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PRECISION OSCILLATOR

MODEL CVO 100 PM

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VOLTAGE DIVIDER PLUG-IN

MODEL 111 PM

OPERATING AND SERVICING MANUAL

WESTON - LEXINGTON
WESTON INSTRUMENTS, INC.
17 HARTWELL AVE., LEXINGTON, MASS. 02173
a Schlumberger company

Serial Number_____

OPERATING AND SERVICE MANUAL

MODEL CVO-100PM

PRECISION OSCILLATOR (MILITARIZED)

Serial Numbers 001-023

Contract No. DAAH01-69-C-1367

WESTON INSTRUMENTS, INC.
Weston-Lexington Division
17 Hartwell Avenue
Lexington, Massachusetts 02173

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W A R R A N T Y

Weston-Lexington warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this Warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose, and to replace any defective parts thereof. This Warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed to the customer. In this case, an estimate will be submitted before the work is started.

IN ANY FAULT DEVELOPS, THE FOLLOWING STEPS SHOULD BE TAKEN:

1. Notify us giving full details of the difficulty; include the Model number and serial number. On receipt of this information, we will give you service data or shipping instructions.
2. On receipt of shipping instructions, forward the instrument prepaid to the factory or to the authorized repair station indicated on the instructions. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SECTION 1

DESCRIPTION AND SPECIFICATIONS

1.1. GENERAL DESCRIPTION

The Weston-Lexington Militarized Precision Oscillator Model 100PM is a double-integrator, phase-shift oscillator covering a frequency range from 10Hz to 100kHz. The oscillator amplitude of 12V rms is held constant to ±0.01% up to 50kHz and waveform purity of 50ppm is typical over most of the operating frequency range. The CVO is also a two-phase oscillator with phase A defined as the reference phase and with phase B lagging phase A by 90° ±0.1° at mid-band. All circuits are fully isolated from the outer case and can be made fully floating with respect to powerline ground by means of a switch provided on the rear panel.

A precision film potentiometer is used for continuous frequency selection providing low noise, high reliability, and a linear-scale dial. This continuous frequency variability is combined with an automatic range-change feature which automatically switches the range switch to the next higher or lower scale when the frequency dial is rotated above or below the range limit. Thus, unidirectional dial rotation permits scanning the entire 10Hz to 100kHz frequency range without use of the range switch (a range switch is also provided for manual override).

Fixed amplitude front-panel outputs are provided for each phase at a low output impedance and are capable of driving a wide variety of external inductive dividers without additional amplification or impedance buffering. Plug-in voltage divider modules provide versatility and permit adding additional capability to handle new requirements at a later date. The CVO-100PM is

normally supplied with a ruggedized model 111PM Voltage Divider Plug-in. A number of other plug-ins are listed in Section 1.3.

The militarized Precision Oscillator includes a number of design improvements in order to insure compliance with all of the environmental requirements of MIS-10272A. Some of the more important features include:

1) All hermetically sealed silicon semiconductors with ruggedized mounting of heat-sinked transistors.
2) All epoxy printed circuit boards treated with a polyurethane moisture-resistant coating.
3) All wide temperature range mica, mylar, tantalum, ceramic or computer grade capacitors, and wire-wound, metal film, or cermet resistors.
4) Large components are provided with mounting clamps and backboard-stiffening plates.
5) Oversized backboard support rails and top cover retain the printed circuit modules in position, under shock and vibration conditions.
6) Each individual unit is thoroughly inspected and tested prior to shipment.

1.2 SPECIFICATIONS

Numbers in parenthesis following the headings refer to applicable paragraph numbers in specification MIS-10272A as ammended 12 February 1969. Refer to section 1.3 of the model 111PM Plug-in Instruction Manual, as well.

Frequency Range (3.3.1)	10Hz-100kHz continuously variable in 4 decade ranges.
Controls	(a) Frequency dial with continuous control over a ten to one range; the dial is mechanically linked to the range multiplier switch for automatic range switching, with uni-directional rotation. (b) Four decade range multiplier switch, operable either automatic-ally as described above or manually. (c) Multi-turn electrical vernier provides ±2% frequency deviation.
Main Dial Calibration Accuracy (3.3.3)	±1% of maximum dial setting, 10Hz-10kHz ±2% of maximum dial setting, 10kHz-100kHz
Resolution (3.3.4)	Electrical vernier permits frequency output to be set to within ±0.01% when using an external counter or Weston-Lexington Model DRO-302 digital readout system. Resolution is continuous, with ±0.01% resetability.
Frequency Stability Vs. Time (3.3.2a)	±0.01%/hr. maximum 100Hz-100kHz after warmup, at constant temperature and line voltage. ±0.02%/hr. maximum 10Hz-100Hz after warmup, at constant temperature and line voltage.
Frequency Stability Vs. Temperature (3.3.2b)	±0.01%/^{o}C maximum,100Hz-100kHz ±0.02%/^{o}C maximum, 10Hz-100Hz
Frequency Stability Vs. Line	±0.005% maximum for 10% line variation.

Frequency Stability Vs. Load	±.01% below 10kHz ±.025% 10kHz-100kHz } no load to full load
Voltage ØA & ØB (3.3.6a)	12.11 volts rms nominal supplied at low impedance to: (a) Plug-in module (b) Front-panel fixed outputs (c) Rear-panel fixed outputs Note: The nominal voltage may be varied by using some types of plug-ins. Refer to plug-in specifications for further information.
Resistive Load (3.3.7)	60ma rms per phase maximum for specified performance. Current available from fixed outputs is reduced by plug-in requirements. Refer to plug-in specifications for further information.

Maximum Capacitive Loading for Specified Performance; either Phase

500pf	(10Hz-10kHz)	Parallel R_L 1KΩ or lower
1000pf	(10kHz-100kHz)	
300pf	(10Hz-10kHz)	Parallel R_L greater than 1KΩ
600pf	(10kHz-100kHz)	

Ratio Transformer Loading	Both ØA and ØB outputs capable of driving most commercial ratio transformers.	
Voltage Accuracy at 400Hz and 25°C	ØA: ±0.05% ØB: ±1%	
Frequency Response, referred to 400Hz, ØA (3.3.10)	ØA: ±0.01% (.001db) ±0.02% (.002db)	20Hz-50kHz 10Hz-20Hz and 50kHz-100kHz
	ØB: ±1% (0.1db) ±5% (0.5db)	10Hz-20kHz to 100kHz

Harmonic Distortion (3.3.5)	ØA:	0.01% Max. 20Hz-50kHz 0.02% Max. 10Hz-20Hz 50kHz-100kHz
	ØB:	Twice the values for ØA.
Amplitude Stability Vs. Time at Constant Temperature & Line, after warmup (3.3.9)	ØA:	8 Hours: ±0.01% Max. One month: ±0.05% Max. 5-10 minutes: ±0.002% typical
	ØB:	Stability figures typically twice those for ØA.
Amplitude Stability Vs. Temperature	ØA:	±0.01%/°C
	ØB:	±0.025%/°C
Amplitude Stability Vs. Line	ØA:	±0.005% Max. for 10% line variation.
Cycle-to-Cylce Stability ØA and ØB		Less than ±0.01% including short-term noise.
Tuning Transients		Maximum amplitude transients for rapid, full-scale rotation of the main tuning dial are typically less than 2% (0.2db); normal, slow dial rotation results in considerably lower transient effects.
Output Impedance 12 volt front-panel fixed outputs	ØA:	25 milliohms series .5 micro-henries
	ØB:	400 milliohms series 2 micro-henries
12 volt rear connector fixed outputs	ØA:	400 milliohms series 1 micro-henry
	ØB:	600 milliohms series 3 micro-henries
	Note: ØA	Amplitude will change ±0.02% above 50kHz for a 0 to full load change on ØB.

	ØB: Amplitude will change 0.4% at 10Hz, and 0.2% above 30Hz for 0 to full load change on ØA.
External Synchronization, Option 05 (3.3.12)	One volt rms frequency-reference signal applied to rear panel J6 BNC input will synchronize the Precision Oscillator over a ±0.5% frequency range.
Quadrature Phase Accuracy	±0.1° (400Hz-10kHz) ±1° (10kHz-100kHz) $\pm .1° \times \frac{400}{f\ (Hz)}$ (10Hz-400Hz)
Line Frequency Beat	Less than ±0.01% near line frequency, or multiples.
DC Component (3.3.6b)	Capacitor-coupled output
Overload Protection	All outputs may be continuously overloaded or short-circuited without damage. The oscillator meets all performance specifications after the overload is removed, except full specified amplitude and frequency stability performance requires several minutes for internal temperature restabilization.
Floating Operation	A rear panel switch is provided which disconnects signal ground from the chassis to allow floating operation.
External Modulation	A rear panel switch is provided to allow amplitude modulation by slowly varying control signals.

Rear Panel Connector Signals (Refer to Block diagram for connector pin numbers)	(a) 12.11V rms fixed, ØA and ØB outputs. (b) Plug-in attenuator outputs (most plug-ins) (c) External modulation input (d) Range switch position contact-closure outputs (e) External synchronization input, J6 (Option 05)
Operating Temperature Range for Specified Performance (3.4.1a)	+4°C to +40°C
Operating Temperature Range	0° to +52°C
Operating Relative Humidity Range for Specified Performance (3.4.1b)	0 to 90%
Operating Altitude Range for Specified Performance (3.4.1c)	0 to 10,000 ft.
Warm-up Time (3.4.1.1)	30 minutes maximum for stated stability.
Power Requirements (3.3.13)	105-130 Volts rms, single phase; 50-400Hz; 80 Watts
Dimensions and Weight (3.2.2 & 3.2.4)	5-1/4" high, 16-7/8" wide, 15-3/4" deep behind front panel; 30 lbs.
Front Panel Finish (3.2.1)	Finished in accordance with manufacturing procedures which are compatible with the requirements of MIL-STD-171.
Front Panel Handles (3.2.6) c	Passivated stainless steel handles conform to maximum L and H dimensions as defined by MS39087 (Ord), Dash No. 1, (5.25 inches and 1.75 inches, respectively).

Connectors (3.2.5)	Input and output signal connectors are BNC type female.
Design and Construction (3.2)	All solid state design and modular construction.
Calibration & Reliability (3.3.14)	The Precision Oscillator will perform without recalibration or readjustment for a minimum of 180 days, 120 of these may be 8 hour continuous operation days.
Non-Operational Environment (3.4.2)	The equipment will operate as specified after being subjected to the following conditions and returned to normal ambient conditions. No damage or performance degradation shall result from these conditions. (a) Stored for 48 hours at minus 55 degrees Centigrade. (b) Stored for 48 hours at plus 60 degrees Centigrade. (c) Stored for 12 hours at 40,000 feet above sea level.
Vibration (3.4.3)	The unit is capable of withstanding a vibration test with the frequency varying from 10 to 55 cycles per second at a total excursion of 0.01 plus 0.006 inches or minus 0.000 inches; the frequency varying uniformly from 10 to 55 cycles per second and returning to 10 cycles per second in approximately 5 minutes in each of the three major axis. No damage or performance degradation shall result from this test.
Vertical and Lateral Shock (3.4.4)	The unit is capable of withstanding vertical and lateral shock of 15 gravity units half sine for 11 milliseconds. No damage or performance degradation shall result from this test.

Tilt Drop (3.4.5)	The equipment is capable of operating satisfactorily without permanent damage or degradation of accuracy after being subjected to a tilt drop test. This test is performed by raising each of the four sides of the unit, using the opposite side as a pivot, at least four inches above the horizontal plane and allowing the unit to drop freely onto a solid surface. No damage or performance degradation shall result from this test.
General Requirements (3.5)	General requirements shall be in accordance with MIL-STD-454, requirements 1, 5A, 7A, 8A, and 9.

1.3 PLUG-IN MODULES AVAILABLE

MODEL NO.	DESCRIPTION
108	Auxiliary Plug-in; provides internal connections necessary for operation.
109	Single phase divider with moderate accuracy and resolution.
110	Two phase divider, same as 109 except 2 phases.
111	High resolution, high accuracy divider (single phase)
114	10 volt standardizer used to set "zero" impedance output level to exactly 10 volts for driving ratio transformers, etc.

1.4 ACCESSORIES AVAILABLE

W-L PART NO.	DESCRIPTION
03-117-280-1	Rack mounting ears (2 Req'd)
29-032-229	Connector, 29 pin female, for use with rear panel output connector
13-117-063	Printed circuit board extender
02-100-178	Tilt stand assembly
02-100-174	Stacking bracket; clamps companion equipment on top of CVO-100 case to conserve bench space.
02-117-307	10:1 Attenuator box for use with Divider Plug-Ins; 50Ω output impedance
02-117-308	600Ω Impedance Adaptor box for use with Divider Plug-Ins.
03-100-183	Slide Mounting Spacer for Johnathan 18" Slides (2 Req'd)

1.5 COMPANION EQUIPMENT

MODEL NO.	DESCRIPTION
HVA-120	Hectovolt Amplifier; provides high level outputs to 120 volts rms at 50 ma, dc to 100kHz, with frequency response, distortion and stability comparable to the series 100 Precision Oscillators.
DRO-300 Series	Computing-type Frequency Counters; display frequency within .01% accuracy, updated 5 times per second even at 10Hz. Provides an accurate frequency source which is rapidly adjustable when used with series 100 Precision Oscillators.
212H/620	NBS test-reportable Peak Comparator and Attenuator may be used for accurate adjustment of output level and for midband linearity calibration, as an alternative to time-consuming thermal-transfer methods.

1.6 RELATED APPLICATION NOTES

The following Application Notes are available from your Weston-Lexington sales representative:

1. USE OF MODEL 212H COMPARATOR WITH MODEL CVO-100 PRECISION OSCILLATOR (AN 10-67/212H-CVO-100/001)
   Describes the proper techniques which will provide the highest accuracies when the Model 212H AC-to-DC Peak Comparator is used in conjunction with the series 100 Precision Oscillators.

2. SIMPLIFIED FREQUENCY RESPONSE MEASUREMENTS (AN 1-68/300/007)
   Describes how recently designed and commercially available equipment can measure frequency response of four terminal networks (transfer characteristics) to within ±0.1% over a wide frequency range with semi-skilled personnel.

3. AN ABSOLUTE 10 VOLT AC REFERENCE TO 100 kHz (AN 10-67/CVO-100/002)
   Describes how a Weston Precision Oscillator with the Model 114 Voltage Standardizer Plug-In and popular ratio transformers provide a low voltage absolute calibration system with excellent wide band performance to 100kHz, at low cost.

4. PHASE ANGLE GENERATION USING CVO-100 (AN 12-67/CVO-100/004)
   Describes how a Weston Precision Oscillator may be used as a phase standard to generate angles from 0° to 360° over a relatively broad band of frequencies to accuracies of better than 0.1°.

5. MEASURING TOTAL HARMONIC DISTORTION OF LESS THAN 0.01% (AN 4-68/CVO-100/010).
   Describes how the use of twin-T filters and wave analyzers offer a means for making accurate distortion measurements of very low-distortion signals which would have been beyond the capabilities of commercially available equipment.

6. NEW CONCEPT IN LOW FREQUENCY COUNTING (AN 1-68/300/005)
   Normal frequency counters measure the number of times a periodic signal passes through a reference voltage in a unit time. This paper describes how it is possible to compute and display directly the frequency of a low frequency signal with high resolution, high accuracy and high speed based on a periodic measurement.

SECTION 2

INSTALLATION

2.1. INITIAL INSPECTION

This instrument has been carefully inspected both mechanically and electrically before shipment and it should be in perfect operating condition and free from all scratches or mars. It should be inspected for physical damage caused in transit to confirm this fact.

2.2. POWER REQUIREMENTS

The Model CVO-100PM may be operated from any source of 115 volts 50 to 400Hz. Power requirements are approximately 80VA. The unit is suppled with a three-conductor power cable such that the instrument case is normally grounded when the cable is plugged into the appropriate receptacle. The ground wire is the offset pin on the power cable.

2.3. FAN OPERATION

Although the Model CVO-100PM is fully transistorized, it is forced air cooled for higher reliability and longer operating life. Because of this fact, care should be taken not to block the fan intake and restrict air circulation. The fan filter should be cleaned regularly to guarantee a long, trouble-free life. The instrument, however, should not be operated where the ambient temperature is in excess of 52°C (125.6°F).

2.4. RACK/BENCH INSTALLATION

The Model CVO-100PM is shipped as a bench-mounted instrument. An accessory rack-mounting kit is available which includes the necessary instructions for installation.

SECTION 3

OPERATION

3.1. INTRODUCTION

All instructions and information necessary for the operation of the Model CVO-100PM is contained in this section.

3.2. CONTROLS AND CONNECTORS

The front and rear panel controls and connectors are identified and illustrated in Figures 3-2 and 3-3.

3.3. TURN-ON PROCEDURE

To turn on the Model CVO-100PM, proceed as follows:

a. Apply ac power to the Model CVO-100PM by plugging in the three conductor power cord supplied with the unit from the power input connector to a proper power receptacle.

b. Push power button: The button should illuminate when the unit is on.

3.4. OPERATING INSTRUCTIONS

For normal operation, proceed as follows:

a. Set floating grounded switch on rear panel to grounded position.

b. Set external modulation switch on rear panel to off position.

3.4.1. FREQUENCY SELECTION

To select a desired frequency, set the multiplier switch to the desired range, set the frequency dial to the appropriate

position and set the frequency vernier to its zero position. Use mechanical vernier for fine frequency adjustments and frequency vernier for very fine frequency adjustments.

3.4.2. RANGE CHANGE

a. Manual: The frequency range may be changed by manually operating the multiplier switch.

b. Autorange: The frequency range may also be changed by turning the frequency dial through the section marked "AUTORANGE". Passing through this section in the clockwise direction changes the range to the next lower position, and counterclockwise rotation changes the range to the next higher position.

3.4.3. AMPLITUDE CONTROLS

The signals are brought to the front-panel reference outputs at very low impedance and at a level of 12.11 volts rms. The signal voltage is also supplied to the plug-in module connector at low impedance. (See manual on plug-in module used for further information and instructions.)

3.4.4. FLOATING OPERATION

If it is desirable to connect the outer case of the Model CVO-100PM to a point other than oscillator output low, set floating/grounded switch in the "FLOATING" position. (It is not recommended to drive the chassis at any frequency above 10Hz because of excessive beat.) The voltage between chassis and circuit ground should not exceed 100 volts peak or dc.

3.4.5. EXTERNAL MODULATION

Set external modulation switch on rear panel to "EXT. MOD" position. The amplitude should drop to 1/2 its value when switch

is in this position. The modulating signal is connected between pins 4 (hi) and 8 (gnd) on the rear connector. The impedance between pins 4 and 8 is 10K ohms. Set the oscillator to the desired carrier frequency (see section 3.4.1.), and adjust the magnitude of the modulating signal for the required modulation. When high percentage modulation is required, it is recommended that the highest modulating frequency be limited to 1/5,000 to 1/10,000 of the carrier (oscillating) frequency. Maximum modulating signal should never exceed 5 volts peak-to-peak.

3.4.6. EXTERNAL SYNCHRONIZATION MODE (Option 05)

Set external synchronization switch to "EXT. SYNC." position. Check fuse which is 1/32 amp type. Connect the synchronizing input signal to J6 on the rear connector. One volt rms into the 7.6K ohms input impedance is necessary for syncrhonization. Adjust the CVO frequency (section 3.4.1) to the synchronizing frequency and observe the Lissajous pattern between the two frequencies as shown in Figure 3-1 below:

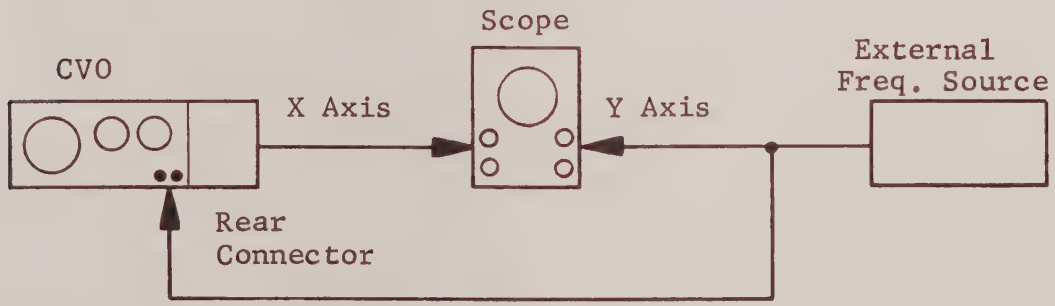
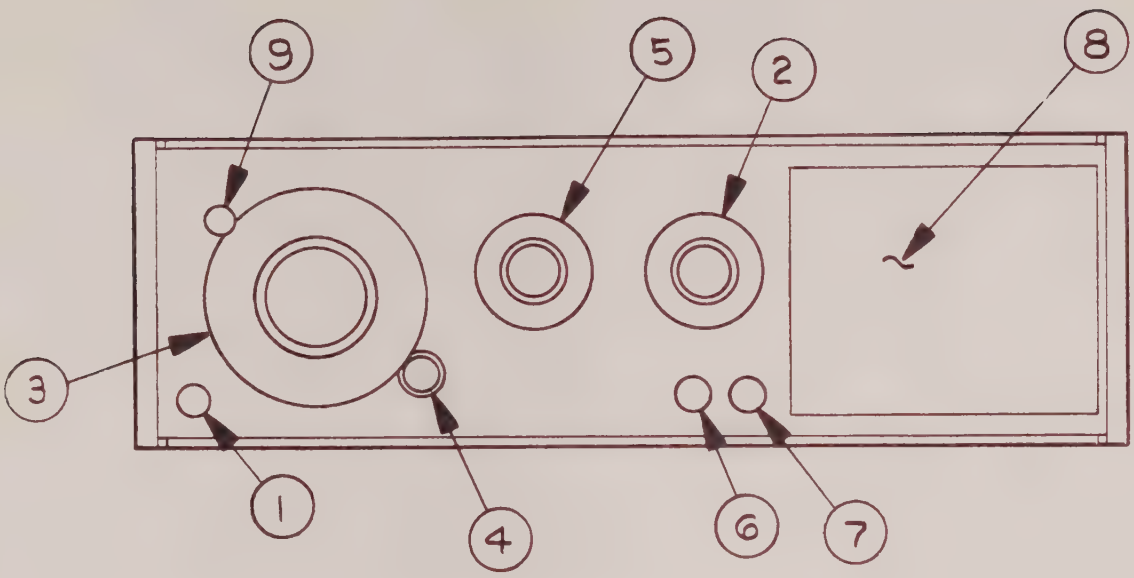


Figure 3-1

Test Circuit for External Synchronization

The oscillator is in synchronization when the Lissajous pattern stops rotating. The oscillator will remain in synchronization for a ±0.5% variation in synchronizing frequency.



1. POWER push button (internally lighted), applied operating power to the unit.

2. MULTIPLIER switch, selects output frequency range.

3. FREQUENCY DIAL adjusts frequency within range setting of multiplier.

4. MECHANICAL VERNIER provides very fine adjustment of frequency dial.

5. FREQUENCY VERNIER provides electrical adjustment of output frequency for extremely fine control.

6. PHASE A OUTPUT (J4) main output of unit.

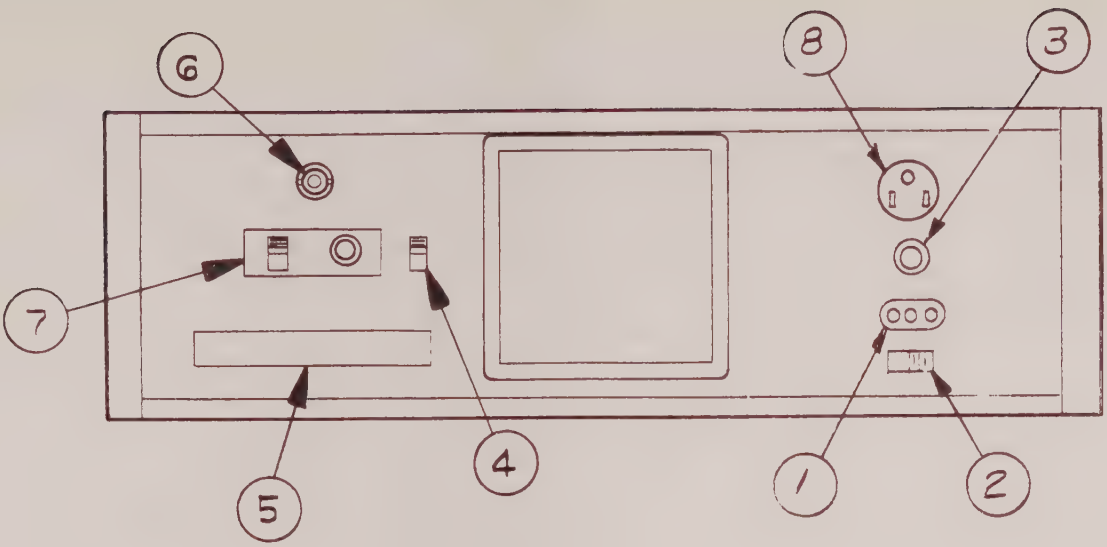
7. PHASE B OUTPUT (J5) lags phase A output by 90°.

8. PLUG-IN CAVITY accepts plug-in modules to extend the operation of the basic CVO.

9. DIAL LOCK secures position of frequency dial.

Figure 3-2

Front Panel Controls and Connectors



1. POWER INPUT connector (J2) accepts the power cord supplied with the instrument.

2. FLOATING/GROUNDED switch (S1) disconnects internal ground from chassis for floating operation.

3. MAIN UNIT FUSE protects internal circuits.

4. EXTERNAL MODULATION switch (S2) allows amplitude to be modulated by external signal.

5. MAIN REAR CONNECTOR (J1) provides plug-in outputs, ØA, ØB, zero output impedance, range switch position information.

6. EXTERNAL SYNCHRONIZATION INPUT connector (J6) accepts BNC cable connector from external frequency-reference source.

7. EXTERNAL SYNCHRONIZATION SWITCH & FUSE PLATE provides external synchronization mode of operation and protects internal circuits against accidental overvoltages applied to J6 external synchronization input.

8. AUXILIARY OUTLET (J7) provides power to accessory equipment, controlled by CVO-100PM front panel "power" switch.

Figure 3-3

Rear Panel Controls and Connectors

SECTION 4

THEORY OF OPERATION

Figure 4-1 shows the dual-integrator oscillator configuration with the addition of the automatic phase-adjusting, amplitude-control feedback loop. Operational amplifiers A1 and A2, in conjunction with R2-C1 and R4-C2 respectively, constitute the integrators; with R2 = R4 and C1 = C2. Ganged precision, infinite-resolution potentiometers R1 and R3 provide continuous frequency variation that is linear with potentiometer ratio and consequently dial setting on each range. Capacitors C1 and C2 are switched in decade steps to furnish decade frequency ranging.

Each integrator furnishes approximately 90° of phase-shift. Operational amplifier A3 supplies the additional 180° to close the oscillating loop. Due to the fact that both A1 and A2 are finite, however, the total loop phase-shift is slightly less than 360°. The additional network from the output of A1 to the summing junction of A3 composed of R7 and R8 in series with the modulator M, supplies a phase-advance, make-up signal.

The current through R7 and R8 is in quadrature with the current through input resistor R5 into inverting amplifier A3, so that for reasonable gains -- say 10,000 -- in A1 and A2, only a small signal is required at E_4 to swing the total feedback vector the incremental phase-shift required.

E_4 is determined by rectifying the output E_2 from amplifier A2, and comparing the result with the potential of a precision zener reference via an integrator I as shown. Use of the integrator supplies a typical gain of over 50,000 for the amplitude-

controlling loop. Integrator output E_5 controls the modulator M, which in turn sets the magnitude of E_4, the incremental phase signal.

Precision infinite-resolution potentiometers R1 and R3 control the frequency at which the loop will oscillate by determining, in conjunction with R2-C1 and R4-C2, the frequency at which net loop gain is unity. R5 is set equal to R6, so that inverter output E_3 equals inverter input E_2. Loading of potentiometers R1 and R3 by integrator input resistors R2 and R4 respectively, is small enough to be neglectable in a first-order analysis. (In the actual instrument, the dial calibration takes into account the small loading effect.) Hence net loop gain is unity at the frequency f_o at which the absolute value of the (identical) integrator gains ($\frac{1}{2\pi f_o R_2 C_1}$ and $\frac{1}{2\pi f_o R_4 C_2}$) are equal to the (identical) attenuations of ganged potentiometers R1 and R3. Thus $E_1 = E_3$ as well since the attenuation through R1 is exactly compensated by the gain through the integrator (R2-A1-C1). E_2 is taken via a precision divider as the main oscillator output E_{01}. E_1 is used -- via another divider -- as a quadrature output E_{02} for applications in which such an output is desirable -- gyro supplies, calibration of phase-sensitive voltmeters and similar measurements areas.

Use of the precision infinite-resolution potentiometers for frequency control provides low-noise performance, with reliability that wirewounds would be unlikely to afford (the potentiometers employed are rated for in excess of 5 million revolutions). Use of potentiometers -- as opposed to rheostats or variable capacitors -- also makes possible a linear frequency dial scale, plus low, virtually constant circuit impedances even at the lower frequencies.

Integrator amplifiers A1 and A2 are stabilized at 6db/octave up to 150 kHz. The slope changes to 12 db/octave from about 150 kHz to within two octaves of crossover which occurs at about 5 MHz, changing to 6 db/octave near crossover. The 12 db/octave stabilization in the instrumentation oscillator application furnishes high loop gain and full drive to higher frequencies, plus lower, wide-band noise and greater freedom from rate-limiting problems, than would be possible with the same closed-loop bandwidth using more conventional 6 db/octave stabilization.

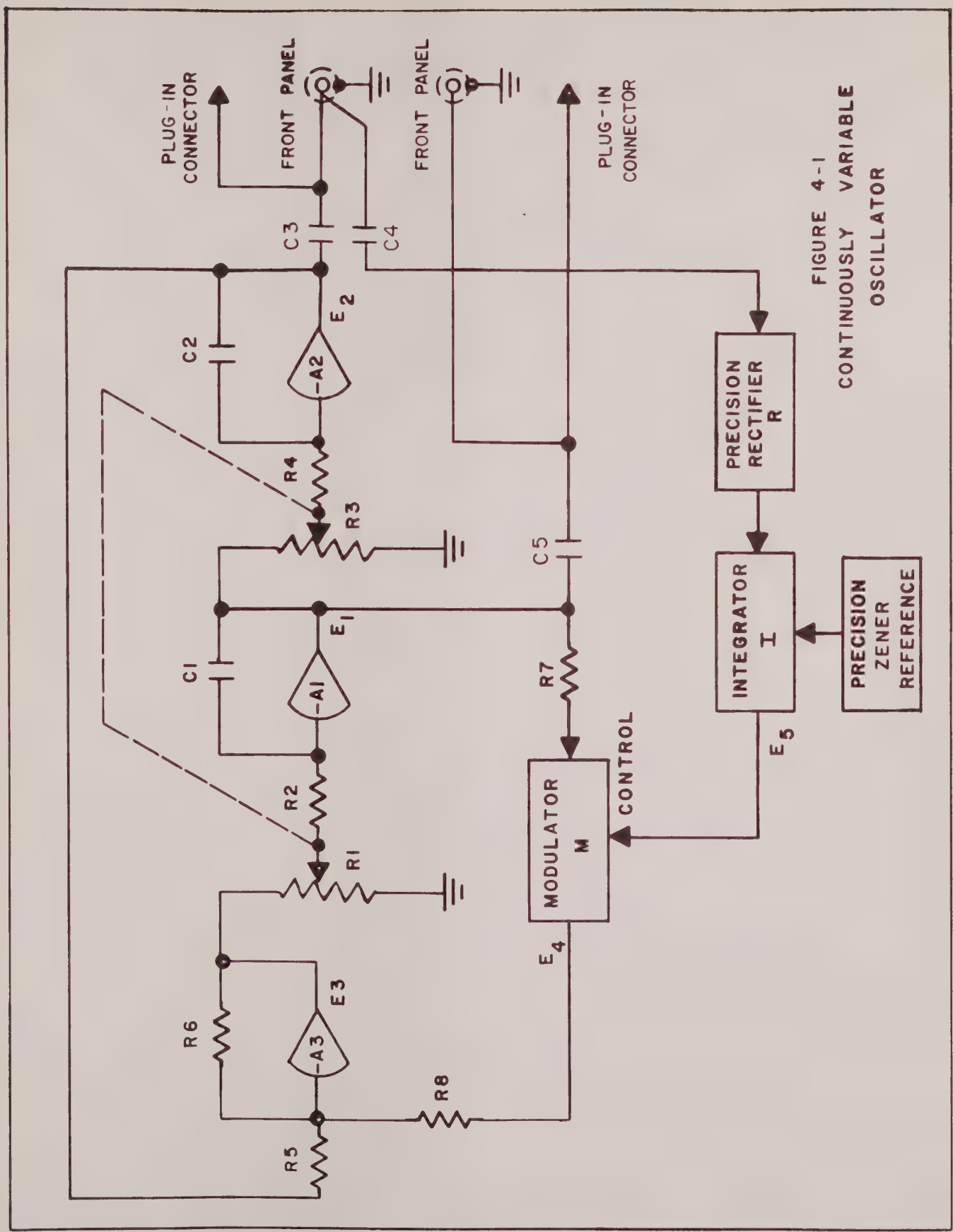


FIGURE 4-1
CONTINUOUSLY VARIABLE OSCILLATOR

SECTION 5

MAINTENANCE AND CALIBRATION

This section contains maintenance and calibration information for the CVO-100PM Precision Oscillator. It is organized under three basic headings: performance tests (5.1), adjustment procedures (5.2), followed by troubleshooting and repair information (5.3).

5.1. PERFORMANCE TESTS

The performance tests are used to verify that the CVO-100PM is operating within its specifications. These tests may be used for initial qualification testing, or for periodic maintenance purposes. The required test equipment is listed in Figure 5-1. If the unit fails any of these tests, refer to the adjustment procedures in section 5.2.

5.1.1. FREQUENCY ACCURACY TEST

This test is used to check the calibration accuracy of the frequency setting dials and range controls.

Set the frequency controls as indicated in Figure 5-2 and measure the output frequency by connecting a Weston series 300 frequency counter to the front-panel ØA BNC connector. Verify that the CVO-100PM is within the limits shown, at each setting.

5.1.2. VOLTAGE ACCURACY & OUTPUT IMPEDANCE TESTS

This test is used to check the voltage accuracy of the ØA and ØB outputs at 400Hz, as well as the output impedance, as shown in Figure 5-3.

5.1.3. FREQUENCY RESPONSE TEST

This test checks the frequency response of the Precision Oscillator over the specified frequency range, referenced to 400Hz, as shown in Figure 5-4. For the ØA measurements, extremely stable and accurate measurement equipment is required. Only the new National Bureau of Standards type "F" coaxial thermal converters, designed by Hermach and Williams, are capable of being certified to sufficient accuracy levels. These converters are described in the following two technical papers: F. Hermach "Thermal Converters for Audio Frequency Voltage Measurements of High Accuracy" IEEE transactions on Instrumentation and Measurement, Dec. 1966, and E. Williams "A Voltage Converter for a New Era", Measurements and Data, Nov-Dec. 1968. Commercially available types are listed in Figure 5-1.

If desired, the ØB output may be checked at the same test frequencies, using a differential voltmeter. The tolerances here are ±1% to 20kHz and ±5% to 100kHz, referenced to the output voltage measured on the ØA output at 400Hz.

5.1.4. DISTORTION TEST

In order to test the Precision Oscillator against its exceptionally low harmonic distortion specifications, band-elimination filters must be used to suppress the fundamental component, in order to reduce self-generated distortion within the wave analyzer as shown in Figure 5-6. These filters can be built in individual aluminum chassis-boxes, using ±2%, 1 watt metal or carbon film resistors and ±5% 200V, capacitors.

Distortion should be measured at nominal frequency settings of 50Hz, 500Hz, 50kHz and 100kHz using the appropriate filters. Use a low frequency wave analyzer for the two lower frequencies; a second, high-frequency wave analyzer is required for the two higher frequency measurements. Near each nominal test frequency, tune the oscillator for minimum fundamental output from the filter (maximum rejection), then measure and record the 2nd through the 5th harmonics of this actual test frequency. Be careful to select high enough input voltage ranges on the wave analyzer in order to prevent self-generated distortion. Use the formula for calculating the percentage of harmonic distortion given in Figure 5-5. The coefficients preceeding each harmonic component in the formula are used to correct for the relative attenuation of the twin T filters at lower-order harmonics.

If distortion is to be measured below 50Hz, a constant-percentage bandwidth type wave-analyzer must be used, such as the General Radio Model 1568-A.

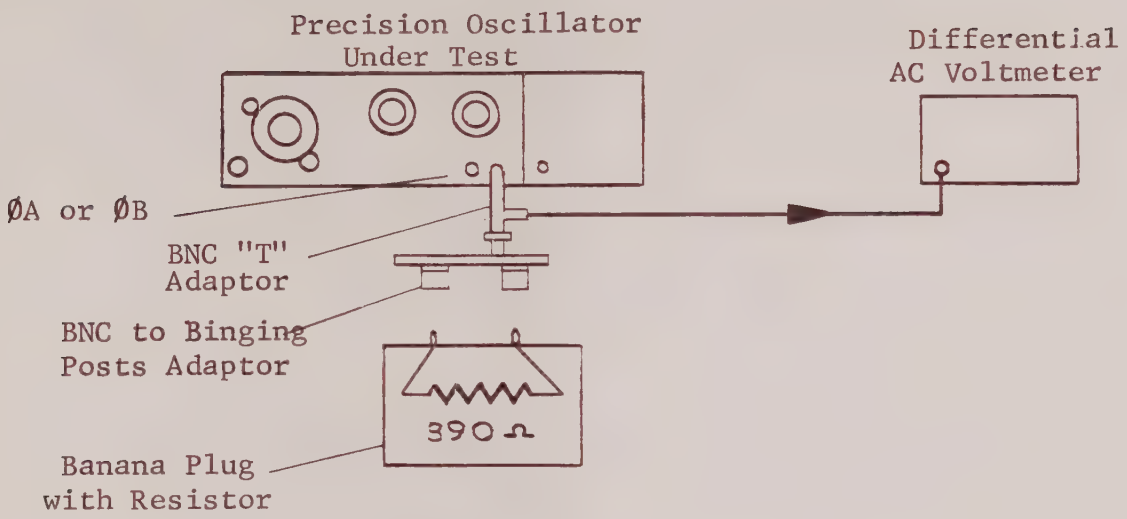
Figure 5-1 Required Equipment for Performance Tests and Adjustments (Figures 5-2 through 5-7)

Description	Used in Fig.	Characteristics	Recommended Manufacturer/Model
Frequency Counter	5-2	.01% accuracy, resolution; 10Hz to 100kHz ranges.	Weston Model 302
Low Frequency Wave Analyzer	5-5	50Hz to 20kHz; residuals 70db down	General Radio 1568-A or Hewlett-Packard 302A
High Frequency Wave Analyzer	5-5	1kHz to 1MHz; residuals 70db down	Hewlett-Packard 310A
Twin-T Filter Boxes: 50, 500, 50k, 100kHz	5-5	$\geq$ 20db rejection at nominal center frequency	Build as shown in Figure 5-6.
AC Differential or Digital Voltmeter	5-3, 5-7	.01% linearity, stability; 100kHz frequency range.	Weston Model PR-840 RMS to-DC Converter with digital voltmeter, or Fluke Model 931-PB ac differential voltmeter.
Oscilloscope	5-7	30MHz bandwidth	Tektronix 531 with "H" Plug-in
DC Millivoltmeter	5-7	1mV sensitivity; 10MΩ input resistance	Hewlett-Packard 427A, or equivalent.
Load Resistor	5-3	390Ω ±5%; 1 watt; metal film	-
Coaxial High Frequency thermal converter with ancillary equipment. (Lindeck Potentiometer and Galvanometer.	5-4	NBS type "F". Refer to paper "thermal converters for Audio-Frequency Voltage Measurements of High Accuracy" IEEE transactions on Instrumentation and Measurement, Dec. 1966.	Holt Instrument Labs. Model 11

Figure 5-2 FREQUENCY ACCURACY TESTS

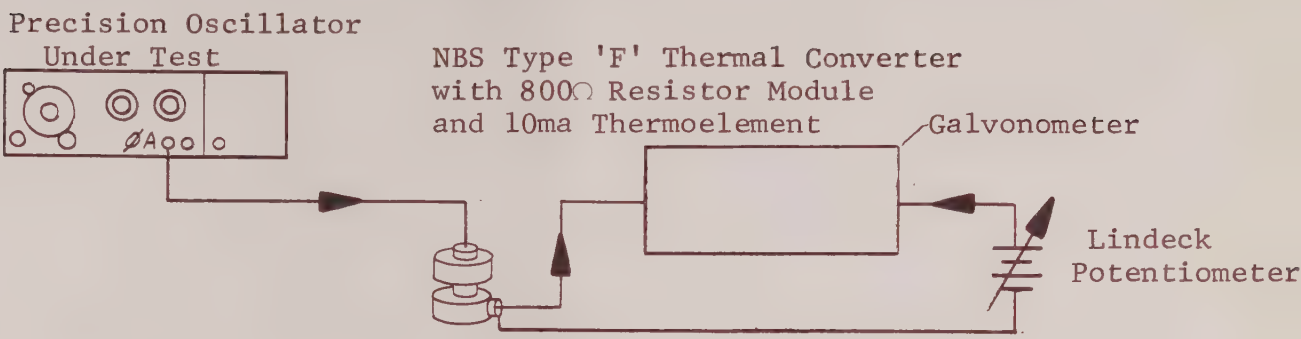
CVO-100PM Frequency Settings Dial	Multiplier	Allowable Limits
1.0	X10	9.00 to 11.00 Hz
2.0	X10	19.00 to 21.00 Hz
5.0	X10	49.00 to 51.00 Hz
10.0	X10	99.00 to 101.00Hz
1.0	X100	90.0 to 110.0 Hz
2.0	X100	190.0 to 210.0 Hz
5.0	X100	490.0 to 510.0 Hz
10.0	X100	990.0 to 1010.0Hz
1.0	X1k	0.900 to 1.100kHz
2.0	X1k	1.900 to 2.100kHz
5.0	X1k	4.900 to 5.100kHz
10.0	X1k	9.900 to 10.100kHz
1.0	X10k	8.00 to 12.00kHz
2.0	X10k	18.00 to 22.00kHz
5.0	X10k	48.00 to 52.00kHz
10.0	X10k	98.00 to 102.00kHz

Figure 5-3 VOLTAGE ACCURACY & OUTPUT IMPEDANCE



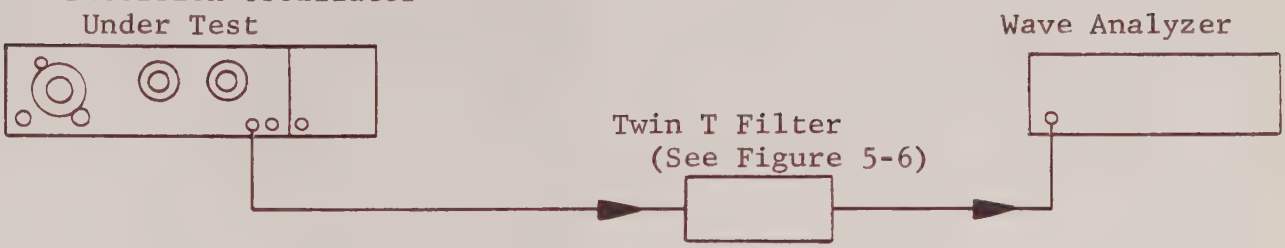
Procedure	Allowable Limits
Set the frequency dial to 4 and the multiplier to X100. Measure the output voltage from the front panel ØB output.	11.989 - 12.231V
Leave the frequency controls set to 400Hz and measure the output voltage from the front panel ØA output	12.1040 - 12.1160V
Leave the frequency controls set to 400Hz. Connecto the BNC "T" and binding post adaptors, but not the load resistor. Null the differential voltmeter. Now connect the load resistor, and note the change in output voltage at ØA.	±0.78mV
Leave the frequency controls set to 400Hz. Connect the BNC "T" and binding post adaptors, but not the load resistor. Null the differential voltmeter. Now connect the load resistor, and note the change in output voltage at ØB.	±12.4mV

Figure 5-4 FREQUENCY RESPONSE TESTS



Procedure	Allowable Limits
Set the Frequency controls for 400Hz. Connect the thermal converter and allow 30 minutes warmup time. Adjust the Lindeck potentiometer for a galvanometer null. Change the frequency dial setting to 1 and the multiplier to X10. Record the galvanometer deflection and the corresponding percentage frequency-response of this 10Hz point relative to the 400Hz reference frequency. Re-check the 400Hz null condition.	Output amplitude at 10Hz must be within ±0.02% of that at 400Hz.
Repeat this procedure for the frequency response of 20Hz relative to 400Hz.	20Hz frequency response: ±0.01% max.
Repeat this procedure for the frequency response of 100Hz (X10 range) relative to 400Hz.	100Hz frequency response: ±0.01% max.
Repeat this procedure for the frequency response of 1000Hz (X100 range) relative to 400Hz.	1000Hz frequency response: ±0.01% max.
Repeat this procedure for the frequency response of 10kHz (X1k range) range to 400Hz.	10kHz frequency response; ±0.01% max.
Repeat this procedure for the frequency response of 50kHz relative to 400Hz.	50kHz frequency response: ±0.01% max.
Repeat this procedure for the frequency response of 100kHz relative to 400Hz.	100kHz frequency response: ±0.02% max.

Figure 5-5 DISTORTION TESTS



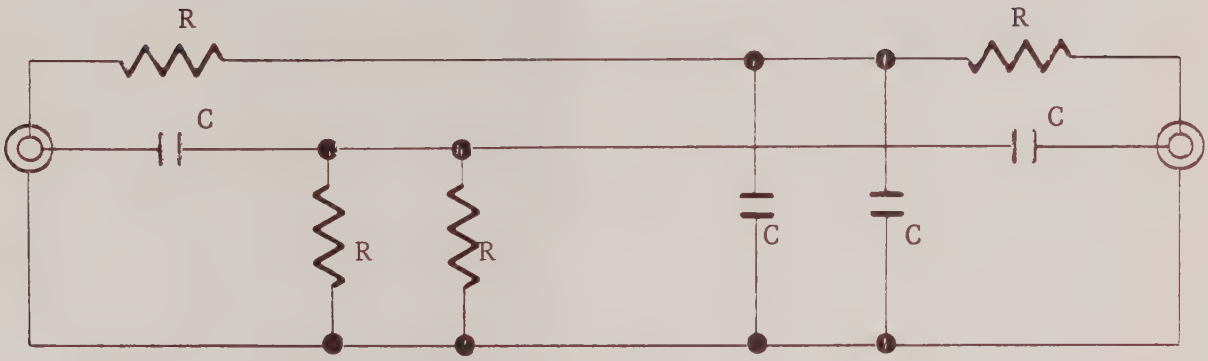
$$\% \text{ Distortion} = \frac{\sqrt{(2.8\ H_2)^2 + (1.8\ H_3)^2 + (1.5\ H_4)^2 + (1.3\ H_5)^2}}{12.11\ V} \times 100\%$$

where: H_n = nth harmonic voltage component measured at output of filter.

Procedure	Allowable Limits
Set the frequency dial to 5 and the multiplier to X10. Connect the 50Hz Filter. Measure and record the second through the fifth harmonic voltages using the low frequency wave analyzer. Calculate the percentage distortion, using the formula above.	0.01% max.
Set the frequency dial to 5 and the multiplier to X100. Connect the 500Hz Filter. Measure and record the second through the fifth harmonic voltages using the low frequency wave analyzer. Calculate the percentage distortion, using the formula above.	0.01% max.
Set the frequency dial to 5 and the multiplier to X10k. Connect the 50kHz Filter. Measure and record the second through the fifth harmonic voltages using the high frequency wave analyzer. Calculate the percentage distortion, using the formula above.	0.01% max.
Set the frequency dial to 10 and the multiplier to X10k. Connect the 100kHz Filter. Measure and record the second through the fifth harmonic voltage using the high frequency wave analyzer. Calculate the percentage distortion, using the formula above.	0.02% max.

Figure 5-6

TWIN T FILTERS



Test Frequency	Component Values	
	R (±2%)	C ±5%
50Hz	33.2kΩ	0.1μF
500Hz	33.2kΩ	0.01μf
50kHz	562Ω	6000pf
100kHz	562Ω	300pf

Figure 5-7 Electrical Adjustment Procedure

The following electrical adjustments are normally sufficient to maintain the equipment within its performance specifications. Required equipment is included in Figure 5-1. All adjustments and test points are identified on the internal calibration cover.

Adjustment	Troubleshooting Symptoms	Circuit Designator		Procedure
		Component	Assembly	
Output Voltage	Inaccurate output voltage from ØA main output	R22	A4	Monitor the ØA main output with an ac differential voltmeter. Set frequency controls to 400Hz. Adjust R22 until the voltmeter reads 12.110 ±0.0006V.
High-End Frequency and Phase-Reference Balance	1. Inaccurate frequency on all ranges at high end of dial. 2. Voltage of rear panel ØB (90°) output different from ØA (0°) output all ranges at high end of dial.	R2 and R11	Backboard	Monitor the ØA main output with an accurate frequency counter; measure voltage at ØB quadrature output with an ac differential voltmeter. Set the frequency dial to 10 on the X100 range. Adjust both potentiometers until the counter reads 1000 ±5Hz and the differential voltmeter reads 12.11 ±0.01V. Clockwise rotation of either control decreases the frequency. Clockwise rotation of R2 or counterclockwise rotation of R11 decreases the voltage.
Low-End Frequency and Phase-Reference Balance	1. Inaccurate frequency on all ranges at low end of dial. 2. Voltage of rear panel ØB (90°) output different from ØA (0°) output on all ranges at low end of dial.	R3 and R7	Backboard	Monitor the ØA main output with an accurate frequency counter; measure voltage at ØB quadrature output with an ac differential voltmeter. Set the frequency dial to 1 on the X100 range. Adjust both potentiometers until the counter reads 100 ±1Hz and the differential voltmeter reads 12.11 ±0.01V. Clockwise rotation of either control decreases the frequency. Clockwise rotation of R3 or counterclockwise rotation of R7 decreases the voltage. Recheck the adjustment of R2 and R11, as indicated in the test above.
100kHz Control Voltage	Excessive Distortion or output voltage disappears or becomes much too large at some high frequency settings.	R10	SW1-D	Monitor TP1-A4 with an oscilloscope (Scope ground lead to frame). Adjust until the peak-to-peak voltage is at least 30mV but not more than 600mV at all frequency dial settings on the 100kHz range. See Note 1
100kHz Frequency and Phase-Reference Balance	1. Inaccurate frequency on 100kHz range 2. Voltage of rear panel ØB (90°) output different from ØA (0°) output on 100kHz range.	C14 and C15	SW1-D SW1-C	Monitor the ØA main output with an accurate frequency counter; measure voltage at the ØB quadrature output with an ac differential voltmeter. Set the frequency dial to 1 on the X10k range. Adjust both capacitors until the counter reads 10.00 ±0.10kHz and the differential voltmeter reads 12.11 ±0.01V. Clockwise rotation of either capacitor decreases the frequency. Clockwise rotation of the front capacitor or counterclockwise rotation of the rear capacitor increases the voltage.
Oscillator DC Offset	Excessive settling-time after changing frequency setting within any range.	R50	A1	Remove the A4 board (to stop oscillation). Monitor TP1-A3 with a dc millivoltmeter. Adjust for minimum variation in dc level between the "1" and "10" settings of the main frequency dial. A variation of 10mV is typical. Replace A4 board.
+36 Regulated Power Supply	Excessive distortion, especially under load.	R18	PB1	Monitor +36V printed circuit line as indicated on the bottom of the upper backboard, using a multimeter. Adjust for 36.0 ±0.5V. Check that -36V supply is correct within ±1 volt (-36V regulator follows adjustment of +36V supply).

Note 1: C13A on A3 has been factory adjusted for constancy of control voltage on the high frequency range; it is not anticipated that the setting will ever have to be readjusted.

5.2 ADJUSTMENT PROCEDURE

This section describes all adjustments which should be necessary to maintain the CVO-100PM within its performance specifications. The equipment should not require readjustment any more frequently than once every six months.

The only mechanical adjustment required is alignment of the Autoshift mechanism (5.2.1); all electrical adjustments are given in section 5.2.2.

5.2.1. AUTOSHIFT MECHANISM ADJUSTMENT

a. Remove the autoshift connecting bar by removing the small E washer holding it to the sprocket and disc assembly. Tighten up on all parts of the connecting bar so as to minimize its length. Remount the connecting bar on the sprocket and disc assembly with the E washer.

b. Set main dial 1/8 inch from panel and tighten the set screw near "6" on the dial such that it bottoms on the flat of the main dial shaft. Wiggle the main dial when setting the screw against the flat.

c. With the range switch set for any range, adjust the connecting bar until a tooth on top of the sprocket is straight up and down. Overadjust the connecting bar until a click occurs at the bottom of the sprocket as the main dial is rotated clockwise: This indicates an interference with the next sprocket tooth. Underadjust the connecting bar until a click occurs at the bottom of the sprocket. Set the adjustment on the connecting bar 1/2 way between the over and under positions and tighten it securely.

d. Go through the ranges and check that the disc pin does not hit a sprocket tooth before engaging the bottom tooth. Adjust the length of the connecting bar as necessary in order to accomplish this result. In the clockwise direction, the autoshift should engage when the "F" on the dial is at the frequency marker. In the counterclockwise direction, the autoshift should engage when the "U" on the dial is at the frequency marker.

e. Set the main dial at "1" and rotate the range switch up and down the ranges. Set the main dial at "10" and repeat the rotation of the range switch. When rotating the range switch, the main dial must not move. If the dial moves, adjust the connecting bar as necessary and then repeat steps d and 4.

5.2.2. ELECTRICAL ADJUSTMENTS

All electrical adjustments are listed in Figure 5-7. The equipment required has been included in Figure 5-1, the location of all adjustments and test points is marked on the internal calibration cover. Be sure to perform these adjustments in the order shown, since several of the adjustments are interacting.

A trim capacitor, C13 on the A4 board was originally provided to adjust the frequency response of the oscillator, but it was later found unnecessary. The frequency response should not normally require adjustment during the life of the equipment. If the high-frequency response seems to be outside of specification limits, excessive control-voltage range is the most likely cause; repeat the "100kHz control voltage" adjustment.

5.3. TROUBLESHOOTING AND REPAIR

If the CVO-100PM is operational, but exhibits minor discrepancies in only one or two performance characteristics over limited voltage or frequency ranges; reference to the "troubleshooting symptom" column in Figure 5-7 will usually locate an adjustment which can be used to correct the problem. If major malfunctioning is indicated, however, first check for the waveforms and voltages shown on the schematic block diagram. Using the circuit diagrams (Section 6) in conjunction with the theory of operation (Section 4), any defective circuits or components can be identified and replaced.

- CAUTION -

Power line voltages may be present on certain terminals normally protected by the internal calibration cover. Exercise caution when operating this equipment with the internal cover removed.

5.3.1. INTERCHANGING CIRCUIT MODULES

Users who own more than one CVO-100PM or spare assemblies will find that circuit faults are most readily isolated by replacing circuit modules, one at a time, with corresponding boards from a second operating instrument, or with spare modules which are known to work in another unit. Mark each module with the unit serial number before interchanging, so that it can be eventually returned to the original unit.

5.3.2. SWITCH BOARD REMOVAL

The four "Switch" boards SW-1B through SW-1E contain only passive components and should seldom require servicing. In order to remove them, the "multiplier" switch shaft and detent mechanism must be moved forward by removing the two screws which mount the detent mechanism to the sub-panel, after removing the front panel knob.

5.3.3. SPARE FUSES

One each spare fuse for the power input F1 (1A) and for the synchronizing input F2 (1/32A) are secured by fuse clips mounted on the capacitor clamp at the middle left-hand side of the unit. They are accessible by merely removing the top outer cover panel.

SECTION 6

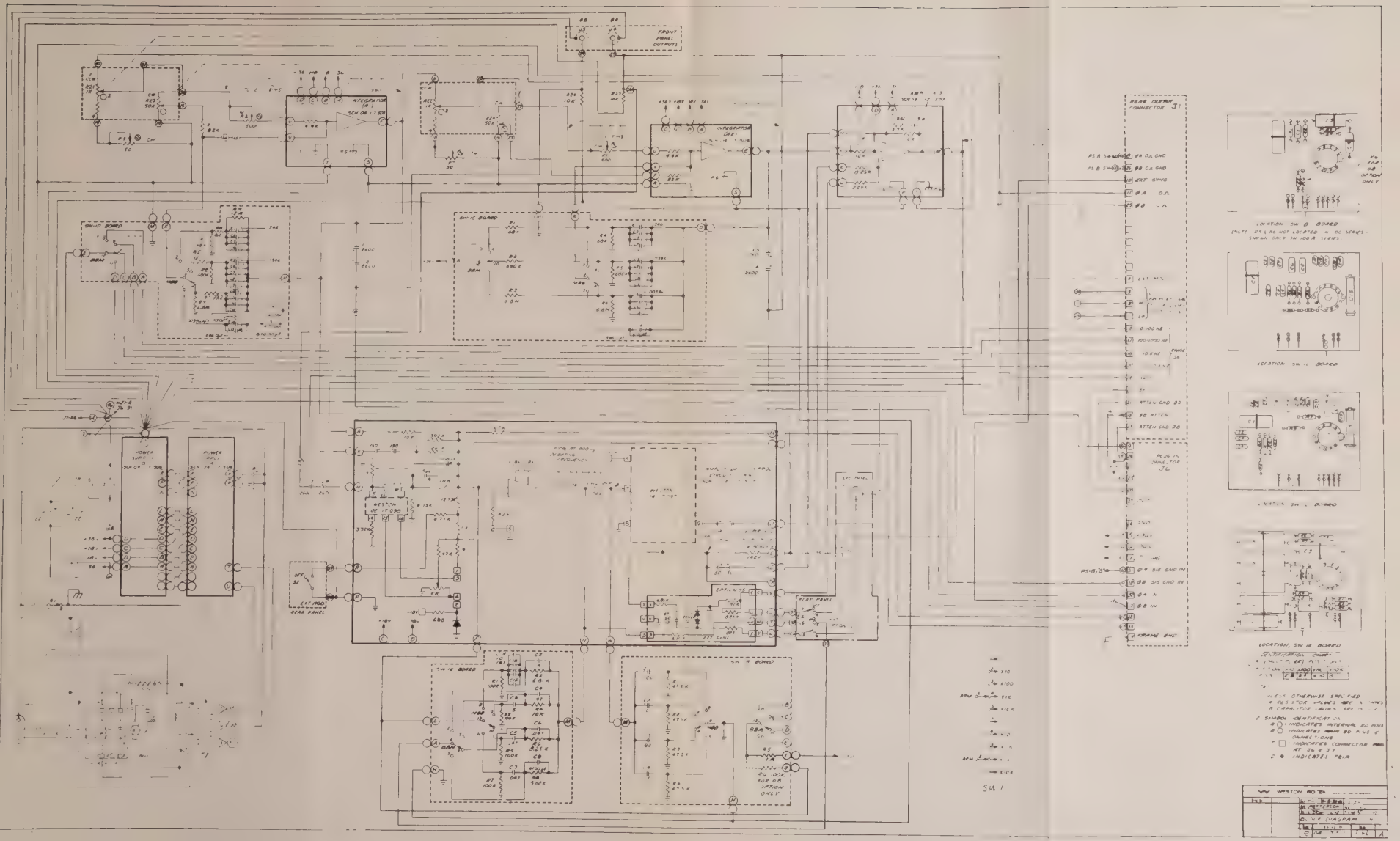
CIRCUIT AND LOCATION DIAGRAMS

This section contains on overall block diagram and assembly location diagram, as well as detailed circuit and location diagrams necessary for maintenance of the Model CVO 100PM.

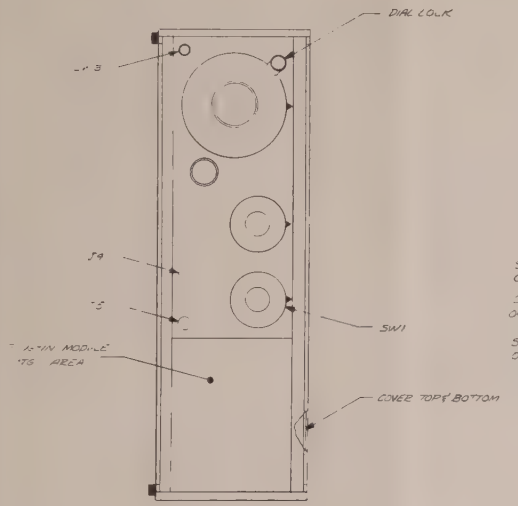
The block diagram when used in conjunction with the Theory of Operation (Section 4), should aid in understanding circuit interrelationships.

Following is a list of the diagrams included in this section.

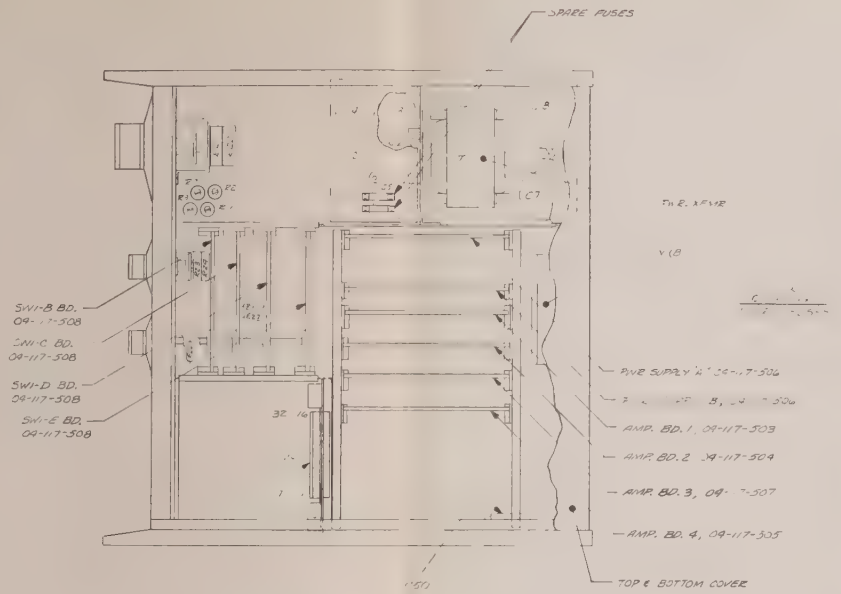
Number	Title
04-117-517	Block Diagram
11-117-434	Overall Location Diagram
04-117-503	Integrator A1
04-117-504	Integrator A2
04-117-505-1	Schematic, Amplitude Control Ckt A4
04-117-505-2	Location, Amplitude Control Ckt A4
04-117-506	Power Supply "A" and "B"
04-117-507	Amplifier A3


FRONT PANEL OUTPUTS
INTEGRATOR (SR)
INTEGRATOR (SR)
SW-IC BOARD
SW-ID BOARD
REAR OUTPUT CONNECTOR J1
REAR PANEL
SW-IA BOARD
SW-IB BOARD
SW-IC BOARD
SW-ID BOARD
LOCATION SW-IB BOARD
LOCATION SW-IC BOARD
LOCATION SW-ID BOARD
LOCATION SW-IA BOARD
WESTON ROTH

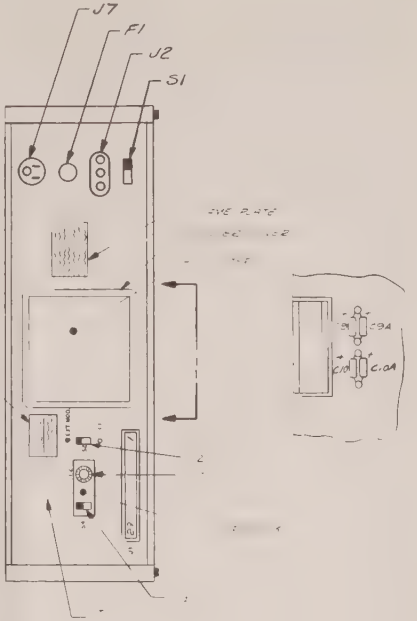
FRONT VIEW

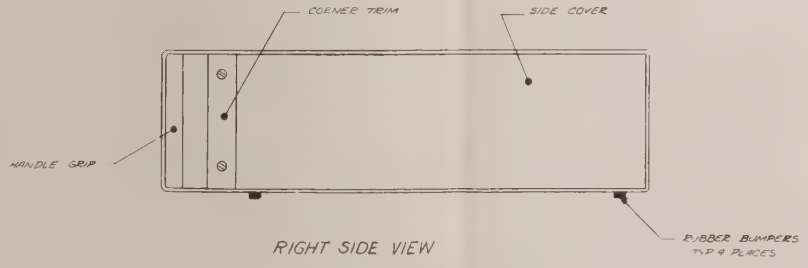


TOP VIEW



REAR VIEW





RIGHT SIDE VIEW

05	EXTERNAL SYNC	S#12,14, A-9 EXT SYNC
0	TYPE	COMPONENT PARTS

OPTIONS

CONTRACT AUTHENTICATION		DATE
DRN	C. Cable	4/11/69
CHK	HUNTER	5/2/69
REVIEW		
ENGR		
APPD		

WESTON ROTEK 19__

REF & M

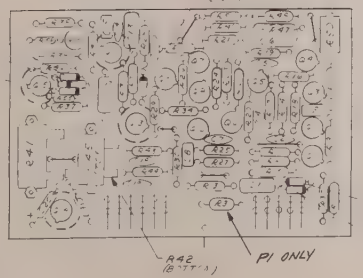
WESTON INSTRUMENTS INC
LEXINGTON DIVISION LEXINGTON, MASS.

LOCATION

CVO - 100 PM

SIZE	CODE IDENT NO.	DRAWING NO
D	11842	11-117-434-A
SCALE NONE	UNIT WT	SHEET 1 OF 1

11-117-434



P1 - 100 (CVO)
101 (CVS)

P2 - 102 (DVO)
103 (DVS)

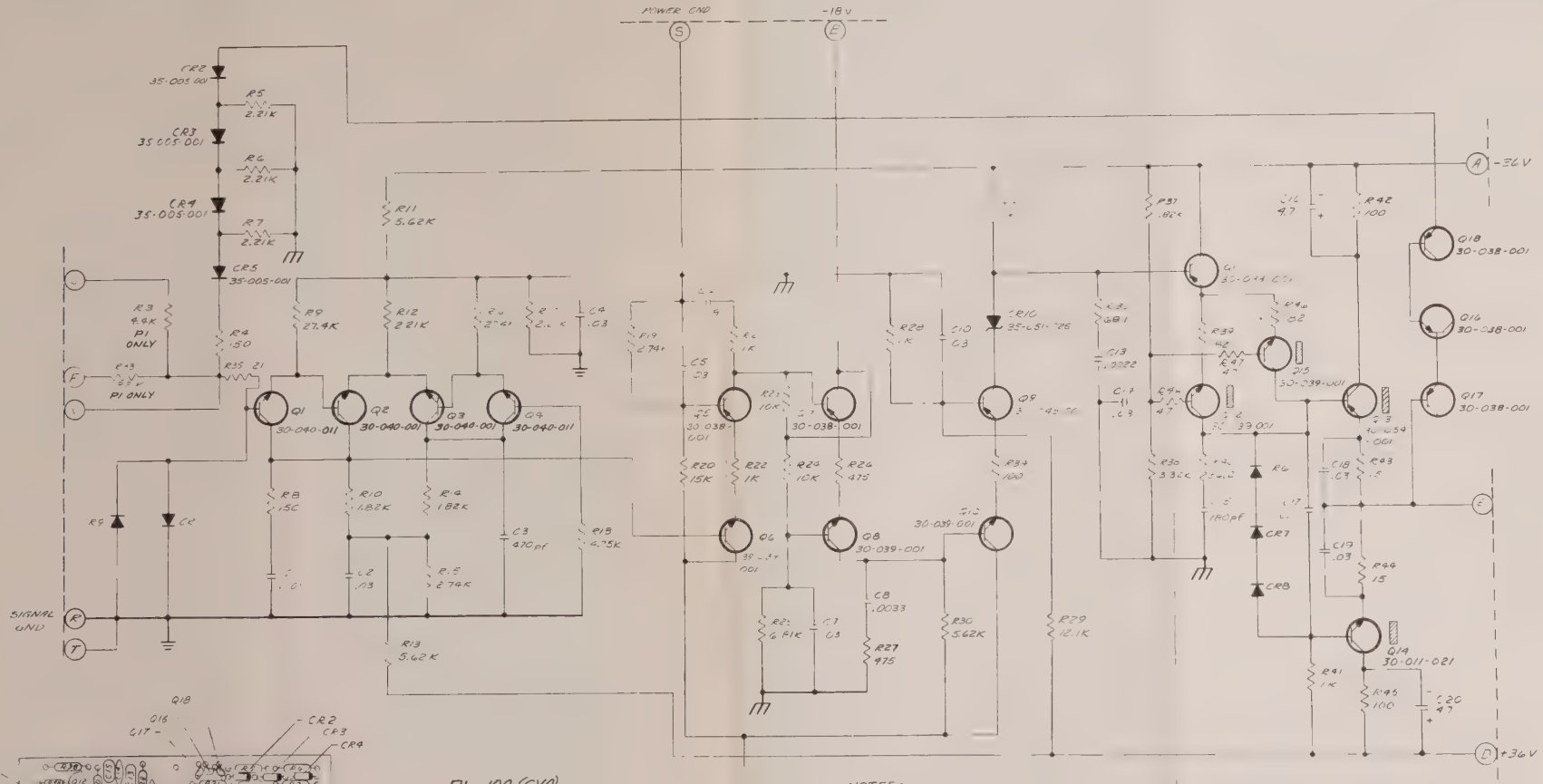
NOTES:

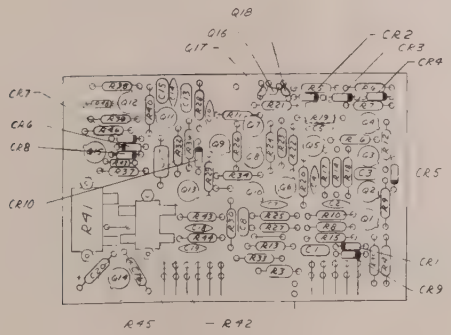
1. UNLESS OTHERWISE SPECIFIED:
   A RESISTOR VALUES ARE IN OHMS
   B CAPACITOR VALUES ARE IN MF.
   C DIODES ARE 35-001-001.
2. CAUTION
   HEAT SINK ON Q13 & 14 ABSOLUTELY ESSENTIAL TO PREVENT OVER DISSIPATION OF TRANSISTOR.

WESTON-ROTEK

CH. 1 FEGEN 1A1

D 04-117-50



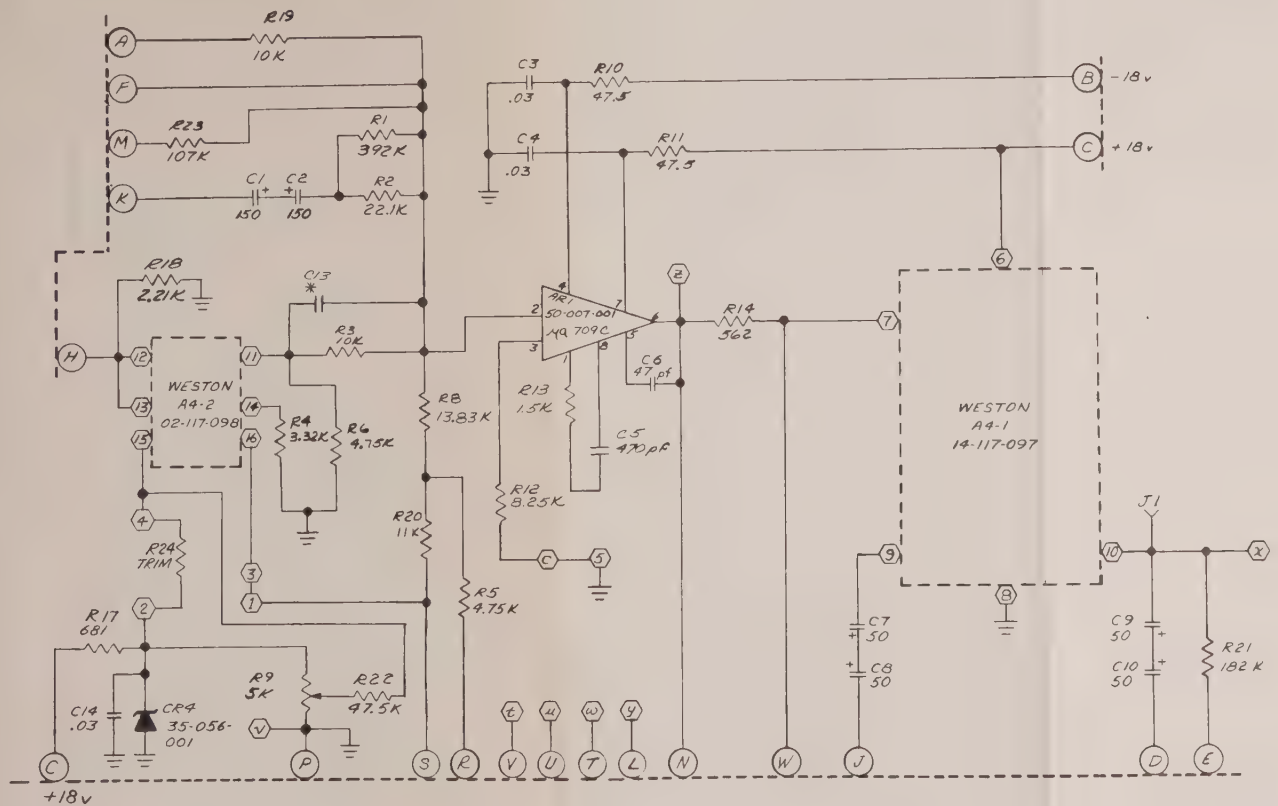


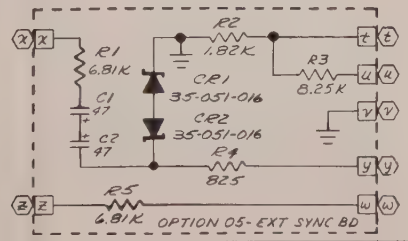
Rev	ECN	Revision	By	Date	Checked
WESTON—ROTEK					
Dwg No		Design/Work	Date	Engineering	
		By		Dwg	9/1/67
		Checked ROGERS		Project	
		INTEGRATOR (A2)			
		Size	Drawing No	Sheet	Rev
		D	04-117-504	1 of 1	E

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   a- RESISTOR VALUES ARE IN OHMS.
   b- CAPACITOR VALUES ARE IN μf.
2. * - TRIM COMPONENT

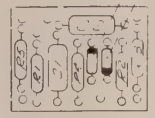
NORMAL OPERATION:
JUMP: 1 → 3
2 → 4
5 → C


R19
10K
R23
107K
R1
392K
C1
150
C2
150
R2
22.1K
C3
.03
R10
47.5
C4
.03
R11
47.5
-18v
+18v
R18
2.21K
C13
*
R3
10K
WESTON
A4-2
02-117-098
R4
3.32K
R6
4.75K
R8
13.83K
R20
11K
R5
4.75K
R24
TRIM
R17
681
C14
.03
CR4
35-056-001
R9
5K
R22
47.5K
+18v
A1
50-007-001
μA 709C
R13
1.5K
C5
470pf
C6
47 pf
R12
8.25K
R14
562
WESTON
A4-1
14-117-097
C7
50
C8
50
J1
C9
50
C10
50
R21
182 K
04-117-505



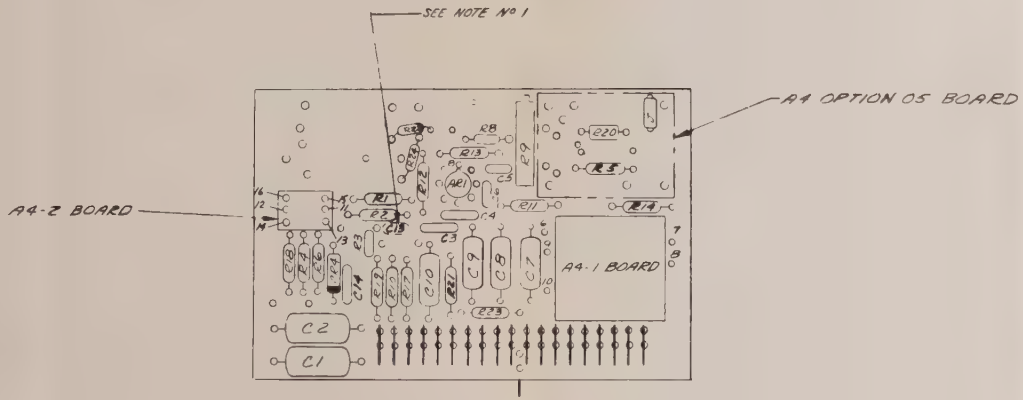
WESTON—ROTEK
WESTON INSTRUMENTS INC.

Dwg. No.	Scale ~	Dr. 19-20	Date 7/7/67
117-038	Drawn K. PATTERSON	App.	7/6/67
117-117	Checked R ROGERS	Proj. Engr. CVO	
	SCHEMATIC, AMPLITUDE CONTROL CKT. A4		
	Size C	Drawing No. 04-117-505	Sheet 1 of 2
			Rev. D



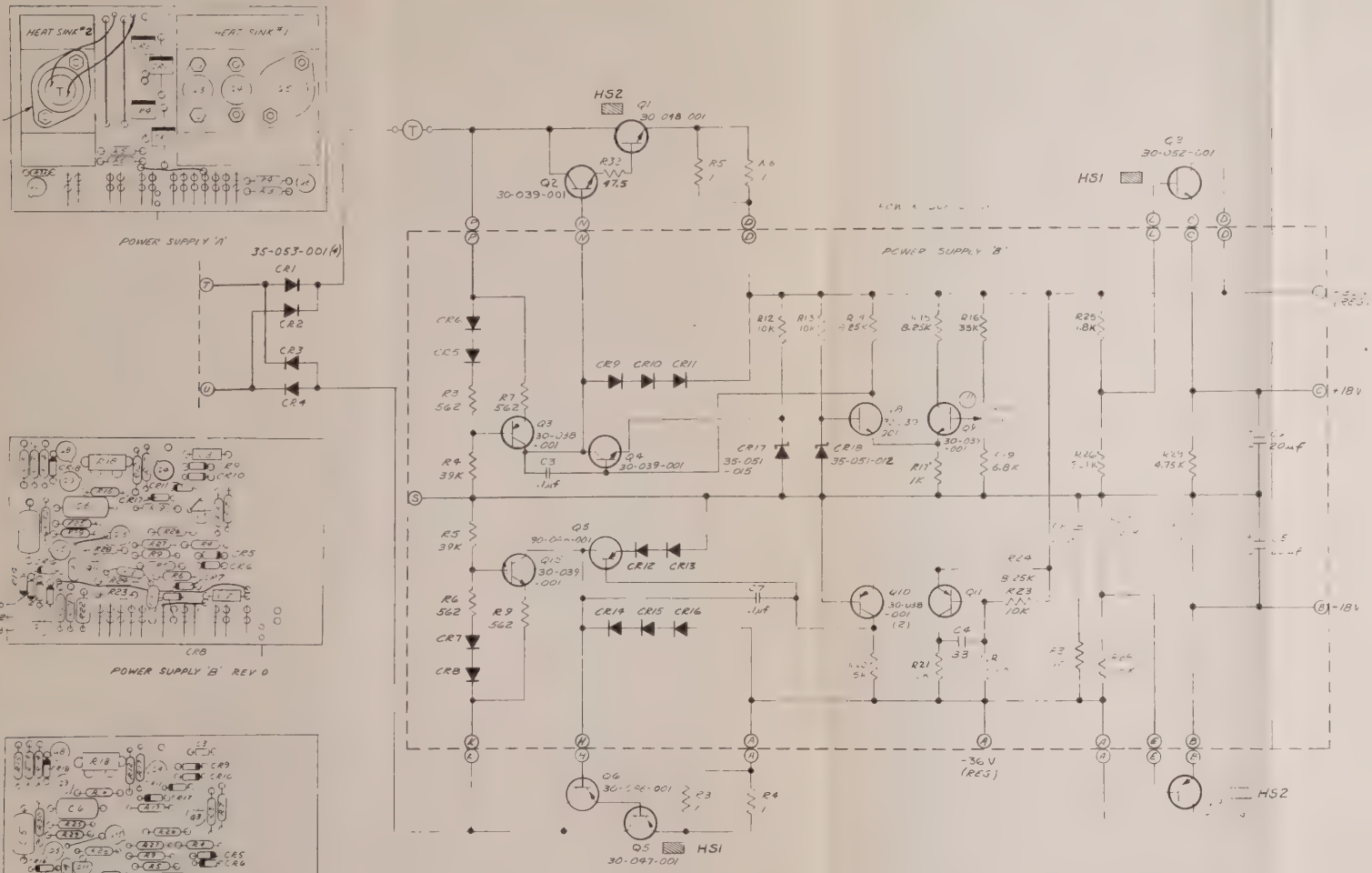
LOCATION
A4 OPTION 05 BOARD

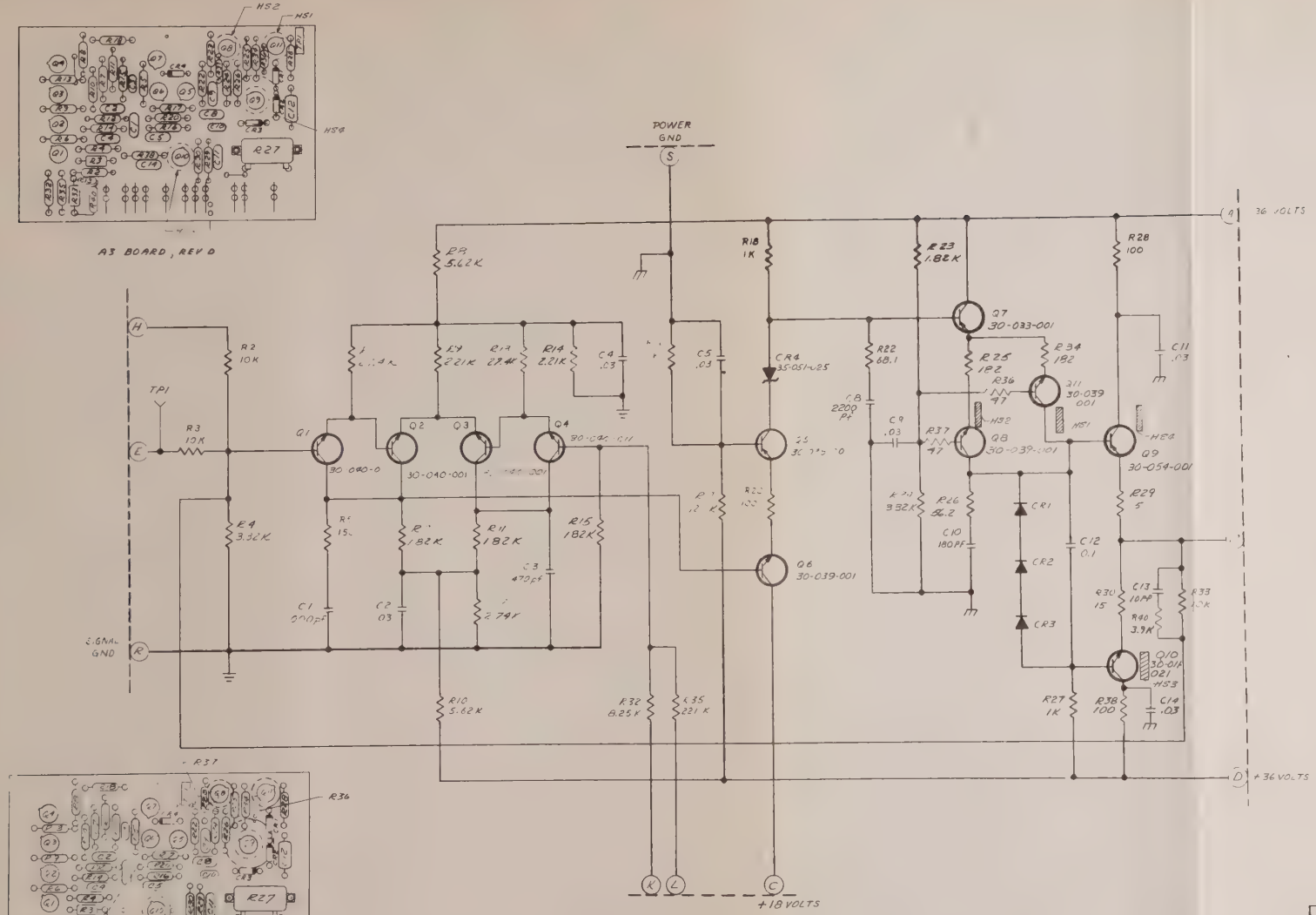
NOTES:
1. C13 IF REQUIRED, TO BE TRIMMED AT TEST.



04-117-505

WESTON—ROTEK WESTON INSTRUMENTS INC.					
23-117-030 23-117-271		RON SIERGIEJ	7/6/67		7/6/67
		R ROGERS	7/6/67	100	
		SCHEMATIC ASSEMBLY SCHEMATIC ART A4			
		C	04-117-505	2 1 2	D


HEAT SINK #2
HEAT SINK #1
POWER SUPPLY 'A'
35-053-001(A)
CR1
CR2
CR3
CR4
POWER SUPPLY 'B' REV D
POWER SUPPLY 'B' REV C
HS2
Q1
30-098-001
Q2
30-039-001
R33
47.5
R5
1.6
HS1
Q8
30-052-001
POWER SUPPLY 'B'
CR6
CR5
R3
562
R7
562
Q3
30-038
-001
Q4
30-039-001
C3
.1μf
R4
39K
CR9
CR10
CR11
R12
10K
R13
10K
Q7
8.25K
R15
8.25K
R16
33K
R25
1.8K
CR17
35-051
-015
CR18
35-051-012
Q9
30-039
-001
R17
1K
R19
6.8K
R26
2.1K
R29
4.75K
C6
20μf
C5
.1μf
R5
39K
Q5
30-038
-001
Q15
30-039
-001
CR12
CR13
R6
562
R9
562
CR7
CR8
CR14
CR15
CR16
C7
.1μf
Q10
30-038
-001
(2)
Q11
R24
9.25K
R23
2.1
10K
C4
33
R21
5K
R3
R4
Q6
30-039-001
Q5
30-047-001
HS1
-36 V
(REG)
+18V
-18V
NOTES
1. UNLESS OTHERWISE SPECIFIED:
A RESISTOR VALUES ARE IN OHMS
B CAPACITOR VALUES ARE IN pf.
C. DIODES ARE 35-001-001.
WESTON-ROTEK
SCHEMATIC, REG. POWER SUPPLY, R5B
D
04-117-506


HS2
HS1
HS3
R27
A3 BOARD, REV D
POWER
GND
+36 VOLTS
+18 VOLTS
SIGNAL
GND
TP1
R2 10K
R3 10K
R4 3.32K
R5 15
R6 182K
R11 182K
R15 182K
C1 500pF
C2 .03
C3 470pF
R10 5.62K
R32 8.25K
R35 221K
R8 5.62K
R18 1K
R23 1.82K
R28 100
R22 68.1
R25 182
R34 182
R36 47
R37 47
C8 2200 pF
C9 .03
C4 .03
C5 .03
C11 .03
CR4 35-051-025
Q7 30-033-001
Q8 30-039-001
Q9 30-059-001
Q6 30-039-001
R26 5K.2
C10 180PF
CR1
CR2
CR3
C12 0.1
R29 5
R30 15
R40 3.9K
C13 10PF
R33 1.0K
Q10 30-018-021
R27 1K
R38 100
C14 .03
NOTES
UNLESS OTHERWISE SPECIFIED:
A RESISTOR VALUES ARE IN OHMS
B CAPACITOR VALUES ARE IN μf
C. DIODES ARE 35-001-001
A3 BOARD, REV A
CH 3 AMPLIFIER (A3)
09-117-507

SECTION 7

REPLACEABLE PARTS

This section contains ordering information for replacement parts listed by assembly. If the value of a component is determined at final test (designated by *), only the manufacturer is given. Where manufacturer and type are not given (designated by **), parts may be ordered directly from Weston-Lexington. These parts should be identified by Weston-Lexington part number; the instrument model number and serial number should also be specified.

Following is a list of assemblies included in this section.

Name	Schematic Number	Page
Frame Assembly	07-117-517	7-2
Integrator Board A1 ▲	04-117-503	7-3
Integrator Board A2 ⚠	04-117-504	7-5
A4 Board ⚠	04-117-505	7-7
Power Supply "A" ⚠	04-117-506	7-8
Power Supply "B" ⚠	04-117-506	7-9
Amplifier A3 ⚠	04-117-507	7-10
SW1-B Board ⚠	04-117-517	7-12
SW1-C Board ⚠	04-117-517	7-13
SW1-D Board ⚠	04-117-517	7-14
SW1-E Board ⚠	04-117-517	7-15
Backboard	04-117-517	7-16
Options	-	7-17
Manufacturers Federal Supply Code		7-18

⚠ Indicates Replaceable Sub-Assembly

FRAME ASSEMBLY 07-117-517

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
	REAR PANEL SUBASSEMBLY			
B1	Fan	26-013-001	IMC Magnetics	BC2206F-2-1
F1	Fuse 3/4ASB 115V	33-010-007	Bussman	MDL obd
XF1	Fuse Holder	33-002-001	Bussman	HKP
SW1 & 2	Sw Slide SPST	34-062-001	H.H. Smith	515
J6	Conn BNC	29-037-001	Dage	UG1094/U
J2	Recp 3 Pin 15A 125V	29-052-001	Towerman	1061-1
J7	Conn 3 Pin Female Line outlet	29-046-001	Amphenol	160-2
	FRAME SUB-ASSEMBLY			
R21,22	Res Var Dual 1K 150mW	40-412-002	**	--
R23,24	Res Var Dual 50K 2W	40-414-001	**	--
T1	Pwr Xfmr	27-346-001-2	**	--
SW3	Sw/Indica DPDT	34-085-001	Marco-Oak	520-1016-21-A1H
J4,J5	Conn BNC Recp	29-057-001	Amphenol	31-105
C50	Cap Clorinol Filled 1.0μf 600V	45-807-001	Sprague	154P113
DS1	Lamp Neon	37-007-001	G. E.	A1H

* obd = order by description

INTEGRATOR BOARD (A1) 04-117-503

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
R43,44	Res Met Film 15Ω 3/4W 1% T-0	40-002-007	IRC	CCB obd
R40	Res Met Film 56.2Ω 3/4W 1% T-0	40-002-021	IRC	CCB obd
R36	Res Met Film 68.1Ω 3/4W 1% T-0	40-002-023	IRC	CCB obd
R42,45	Res Pwr 100Ω 10W 5%	40-203-031	Memcor	MOR-10 obd
R35	Res Met Film 121Ω 3/4W 1% T-0	40-002-029	IRC	CCB obd
R8	Res Met Film 150Ω 3/4W 1% T-0	40-002-031	IRC	CCB obd
R39,46	Res Met Film 182Ω 3/4W 1% T-0	40-002-033	IRC	CCB obd
R26,27	Res Met Film 475Ω 3/4W 1% T-0	40-002-043	IRC	CCB obd
R21,22,28,32	Res Met Film 1K 3/4W 1% T-0	40-002-053	IRC	CCB obd
R10,14,37	Res Met Film 1.82K 3/4W 1% T-0	40-002-059	IRC	CCB obd
R12,17,47,48	Res Met Film 2.21K 3/4W 1% T-0	40-002-063	IRC	CCB obd
R15,19	Res Met Film 2.74K 3/4W 1% T-0	40-002-065	IRC	CCB obd
R38	Res Met Film 3.32K 3/4W 1% T-0	40-002-067	IRC	CCB obd
R18	Res Met Film 4.75K 3/4W 1% T-0	40-002-071	IRC	CCB obd
R11,13,30	Res Met Film 5.62K 3/4W 1% T-0	40-002-073	IRC	CCB obd
R25	Res Met Film 6.81K 3/4W 1% T-0	40-002-075	IRC	CCB obd
R23,24,49,51	Res Met Film 10K 3/4W 1% T-0	40-002-079	IRC	CCB obd
R29	Res Met Film 12.1K 3/4W 1% T-0	40-002-081	IRC	CCB obd
R20	Res Met Film 15K 3/4W 1% T-0	40-002-083	IRC	CCB obd
R9,16	Res Met Film 27.4K 3/4W 1% T-0	40-002-089	IRC	CCB obd
R50	Res Var 5K	40-418-009	Helipot	77PR5K
R41	Res Pwr 1K 15W 5%	40-221-001	Memcor	1-BRS-53B-B410
R3	Res WW 4.4K .33W 0.1% 7ppm/°C	40-187-001	Daven	1301 obd
R55,56	Res 47Ω 1/4W 10%	40-012-012	Allen-Bradley	CB4701
R34	Res Met Film 100Ω 3/4W 1% T-0	40-002-027	IRC	CCB obd
R52	Res Met Film 100K 3/4W 1% T-0	40-002-103	IRC	CCB obd
C2,4,5,7,10, 14,18,19	Cap Cer .03μf 50V +80% -20%	45-902-002	Centralab	CK-303
C15	Cap Mica 180pf 300V 3%	45-003-013	Electro-Motive	DM15F181H0300 WV4CR
C3	Cap Mica 470pf 300V 3%	45-003-023	Electro Motive	DM15F471H0300 WV4CR

* obd = order by description

INTEGRATOR BOARD (A1) CONTINUED 04-117-503

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
C1	Cap Mica 1000pf 300V 3%	45-004-001	Electro-Motive	DM19F102H0300 WV4CR
C13	Cap Mica 2200pf 300V 3%	45-004-009	Electro-Motive	DM19F222H0300 WV4CR
C8	Cap Mica 3300pf 300V 3%	45-004-013	Electro-Motive	DM19F332H0300 WV4CR
C6	Cap Mica 1800pf 100V 2%	45-008-002	Electro-Motive	DM20E183H0300 WV4CR
C17	Cap Mylar 0.1µf 200V 10%	45-108-501	Sprague	192P10492
C16,20	Cap Ta 4.7µf 50V 20%	45-412-001	Sprague	150D475X0050B2
CR1,6-9	Diode Si Sw 200mA 120 PIV	35-001-001	Fairchild	1N658
CR10	Diode Si Ref 24V 400mW	35-051-025	Motorola	MZ-500-25
Q11,5,7,9△	Tstr PNP Si	30-033-001	**	--
Q6,8,10,12,15	Tstr NPN Si	30-039-001	Sprague	TN53
Q1-4	Tstr NPN Si	30-040-011	**	--
Q13	Tstr PNP Si	30-054-001	Motorola	2N3634
Q14	Tstr NPN Si	30-011-021	**	--
HS1,2,3,4	Heat Sink Top Hat JEDEC Type TO-5	55-003-001	Wakefield Eng	207
△	Schematic Reference Q5 & 7 - 30-038-001 Q9 - 30-045-001	Changed to 30-033-001	**	--

* obd = order by description

INTEGRATOR BOARD (A2) 04-117-504

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
R43,44	Res Met Film 15Ω 3/4W 1% T-0	40-002-007	IRC	CCB obd
R40	Res Met Film 56.2Ω 3/4W 1% T-0	40-002-021	IRC	CCB obd
R36	Res Met Film 68.1Ω 3/4W 1% T-0	40-002-023	IRC	CCB obd
R34	Res Met Film 100Ω 3/4W 1% T-0	40-002-027	IRC	CCB obd
R35	Res Met Film 121Ω 3/4W 1% T-0	40-002-029	IRC	CCB obd
R4,8	Res Met Film 150Ω 3/4W 1% T-0	40-002-031	IRC	CCB obd
R39,46	Res Met Film 182Ω 3/4W 1% T-0	40-002-033	IRC	CCB obd
R26,27	Res Met Film 475Ω 3/4W 1% T-0	40-002-043	IRC	CCB obd
R21,22,28,32	Res Met Film 1K 3/4W 1% T-0	40-002-053	IRC	CCB obd
R10,14,37	Res Met Film 1.82K 3/4W 1% T-0	40-002-059	IRC	CCB obd
R5-7,12,17	Res Met Film 2.21K 3/4W 1% T-0	40-002-063	IRC	CCB obd
R15,19	Res Met Film 2.74K 3/4W 1% T-0	40-002-065	IRC	CCB obd
R38	Res Met Film 3.32K 3/4W 1% T-0	40-002-067	IRC	CCB obd
R18	Res Met Film 4.75K 3/4W 1% T-0	40-002-071	IRC	CCB obd
R11,13,30	Res Met Film 5.62K 3/4W 1% T-0	40-002-073	IRC	CCB obd
R25	Res Met Film 6.81K 3/4W 1% T-0	40-002-075	IRC	CCB obd
R23,24	Res Met Film 10K 3/4W 1% T-0	40-002-079	IRC	CCB obd
R29	Res Met Film 12.1K 3/4W 1% T-0	40-002-081	IRC	CCB obd
R20	Res Met Film 15K 3/4W 1% T-0	40-002-083	IRC	CCB obd
R9,16	Res Met Film 27.3K 3/4W 1% T-0	40-002-089	IRC	CCB obd
R33	Res Met Film 82.5K 3/4W 1% T-0	40-002-101	IRC	CCB obd
R41	Res Pwr 1K 15W 5%	40-221-001	Memcor	1-BRS-53B-B410
R3	Res Met Film 4.4K .3W 0.1% 7ppm/°C	40-006-002	Vishay	S102 obd
R42,45	Res Pwr 100Ω 10W 5%	40-203-031	Memcor	MOR-10 obd
R47,48	Res 47Ω 1/4W 1%	40-012-012	Allen-Bradley	CB4701
C2,4,5,7,10, 14,18,19	Cap Cer .03μf 50V +80% -20%	45-902-002	Centralab	CK303
C15	Cap Mica 180pf 300V 3%	45-003-013	Electro-Motive	DM15F181H0300 WV4CR

* obd = order by description

INTEGRATOR BOARD (A2) CONTINUED 04-117-504

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
C3	Cap Mica 470pf 300V 3%	45-003-023	Electro-Motive	DM15F471H0300 WV4CR
C1	Cap Mica 1000pf 300V 3%	45-004-001	Electro-Motive	DM19F102H0300 WV4CR
C13	Cap Mica 2200pf 300V 3%	45-004-009	Electro-Motive	DM19F222H0300 WV4CR
C8	Cap Mica 3300pf 300V 3%	45-004-013	Electro-Motive	DM19F332H0300 WV4CR
C6	Cap Mica .018µf 100V 2%	45-008-002	Electro-Motive	DM20E183H0300 WV4CR
C17	Cap Mylar 0.1µf 200V 10%	45-108-501	Sprague	192P10492
C16,20	Cap Ta 4.7µf 50V 20%	45-412-001	Sprague	150D475X0050B2
CR1,6-9	Diode Si 200mA 120 PIV	35-001-001	Fairchild	1N658
CR2-5	Diode Si 75mA 50 PIV	35-005-001	Fairchild	FD100
CR10	Diode Si Ref 24V 400mW	35-051-025	Motorola	MZ500-25
CR11	Diode Si Ref 18V 750mW	35-035-001	Motorola	1N1515A
Q16,17 &18	Replaced with CR11 (Cathode to Pin E)			
Q11,5,7,9 ▲	Tstr PNP Si	30-033-001	**	--
Q6,8,10,12,15	Tstr NPN Si	30-039-001	Sprague	TN53
Q1-4	Tstr NPN Si	30-040-011	**	--
Q13	Tstr PNP Si	30-054-001	Motorola	2N3634
Q14	Tstr NPN Si	30-011-021	**	--
HS1,2,3,4	Heat Sink Top Hat JEDEC Type TO-5	55-003-001	Wakefield Eng	207 obd

* obd = order by description

INTEGRATOR BOARD (A2) CONTINUED 04-117-504

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
Δ	Schematic Reference Q5 & 7 - 30-038-001 Changed to 30-033-001 Q9 - 30-045-001		**	--

* obd = order by description

A4 BOARD 04-117-505

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
R10,11	Res Met Film 47.5Ω 3/4W 1% T-0	40-002-019	IRC	CCB obd
R14	Res Met Film 562Ω 3/4W 1% T-0	40-002-045	IRC	CCB obd
R17	Res Met Film 681Ω 3/4W 1% T-0	40-002-049	IRC	CCB obd
R13	Res Met Film 1.5K 3/4W 1% T-0	40-002-057	IRC	CCB obd
R18	Res Met Film 2.21K 3/4W 1% T-0	40-002-063	IRC	CCB obd
R4	Res Met Film 3.32K 3/4W 1% T-0	40-002-067	IRC	CCB obd
R5,6	Res Met Film 4.75K 3/4W 1% T-0	40-002-071	IRC	CCB obd
R12	Res Met Film 8.25K 3/4W 1% T-0	40-002-077	IRC	CCB obd
R3	Res Met Film 10K 0.3W 0.1% 5ppm/°C	40-006-001	Vishay	S102 obd
R2	Res Met Film 22.1K 3/4W 1% T-0	40-002-087	IRC	CCB obd
R21	Res Met Film 182K 3/4W 1% T-0	40-002-109	IRC	CCB obd
R23	Res WW 107K 1/4W 0.1% ±5ppm	40-103-302	Daven	1274 obd
R1	Res Met Film 392K 3/4W 1% T-0	40-002-117	IRC	CCB obd
R22	Res Met Film 47.5K 3/4W 1% T-0	40-002-095	IRC	CCB obd
R20	Res WW 11K 1/4W 0.1% 7ppm/°C	40-176-204	Daven	1250 obd
R9	Res Var 5K .75W 10T	40-409-009	Helipot	75PR5K
R19	Res Met Film 10K 3/4W 1% T-0	40-002-079	IRC	CCB obd
R8	Res WW 13.83K 1/4W 0.1% ±5ppm	40-103-069	Daven	1274 obd
C7,8,9,10	Cap Ta 47µf 15V	45-409-001	Sprague	150D476X0015R2
C1,2	Cap Ta 150µf 15V	45-409-002	Sprague	150D157X0015S2
C3,4,14	Cap Cer .03µf 50V +80% -20%	45-902-002	Centralab	CK-303
C13	Cap Mica Trim 300V	*	Electro-Motive	-
C6	Cap Mica 47pf 300V 3%	45-002-005	Electro-Motive	DM15F6470H0300 WV4CR
C5	Cap Mica 470pf 300V 3%	45-003-023	Electro-Motive	DM15F471H0300 WV4CR
CR4	Diode Si Ref 11.7V 750mW 5%	35-056-001	Motorola	1N3581

* obd = order by description

A4 BOARD CONTINUED 04-117-505

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
AR1	Ampl Int Ckt	50-007-001	Fairchild	µA709C
△	Schematic reference C7,8,9,10	50µf changed	to 47µf	
A4-1	Assy Potted	02-117-097	Weston	--
A4-2	Assy Potted	02-117-098	Weston	--
R24	Res Trim	*		
TP1	Test Jack P.C. Red	29-024-001	H.H.Smith	430-102 obd

* obd = order by description

POWER SUPPLY A 04-117-506

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
R3-6	Res Pwr 1Ω 3W 5%	40-219-001	Ward-Leonard	3X obd
R1,2	Res Pwr 5Ω 10W 5%	40-220-001	Ward-Leonard	10XM obd
CR1-4	Diode Sil Rect 3A 200 PIV	35-053-001	Motorola	MR2071
Q2	Tstr NPN Si	30-039-001	Sprague	TN53
Q6	Tstr PNP Si	30-086-001	RCA	2N4314
Q4	Tstr PNP Si	30-046-001	Motorola	MJ2253
Q5	Tstr PNP Si	30-047-001	Motorola	MJ2268
Q1	Tstr NPN Si	30-048-001	Motorola	MJ2256
Q3	Tstr NPN Si	30-052-001	Motorola	MJ2249
R32	Res Met Film 47.5Ω 3/4W 1% T-0	40-002-019	IRC	CCB obd
SW1	Thermo Open 195°F: Close 155°F	41-005-003	Klixon - T.I.	20700L41-116-L195-4
HS1	Heat Sink	10-117-080	Weston	--
HS2	Heat Sink	10-117-081	Weston	--

* obd = order by description

POWER SUPPLY B 04-117-506

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
R3,6,7,9	Res Met Film 562Ω 3/4W 1% T-0	40-002-045	IRC	CCB obd
R17	Res Met Film 1K 3/4W 1% T-0	40-002-053	IRC	CCB obd
R25,28	Res Met Film 1.82K 3/4W 1% T-0	40-002-059	IRC	CCB obd
R27	Res Met Film 2.21K 3/4W 1% T-0	40-002-063	IRC	CCB obd
R29,30	Res Met Film 4.75K 3/4W 1% T-0	40-002-071	IRC	CCB obd
R19	Res Met Film 6.81K 3/4W 1% T-0	40-002-075	IRC	CCB obd
R14,15,24	Res Met Film 8.25K 3/4W 1% T-0	40-002-077	IRC	CCB obd
R12,13,21	Res Met Film 10K 3/4W 1% T-0	40-002-079	IRC	CCB obd
R20	Res Met Film 15K 3/4W 1% T-0	40-002-083	IRC	CCB obd
R16	Res Met Film 33.2K 3/4W 1% T-0	40-002-091	IRC	CCB obd
R4,5	Res Met Film 39.2K 3/4W 1% T-0	40-002-093	IRC	CCB obd
R18	Res Var 2K 2W	40-418-008	Helipot	77PR2K
R22,23	Res WW 10K 1/4W 0.1% 7ppm/°C	40-176-200	Daven	1250 obd
R31	Res Met Film 10Ω 3/4W 1% T-0	40-002-003	IRC	CCB obd
R26	Replaced with CR19			
C5,6	Cap Ta 22μf 50V	45-418-001	Sprague	150D226X0050S2
C3,7	Cap Mylar .1μf 100V 10%	45-102-004	Electro-Motive	P710411
C8	Cap Mylar .01μf 100V 10%	45-101-003	Electro-Motive	P710311
CR5-16	Diode Si 200mA 120PIV	35-001-001	Fairchild	1N658
CR18	Diode Si Ref 6.8V 400mW	35-051-012	Motorola	MZ500-12
CR17	Diode Si Ref 9.1V 400mW	35-051-015	Motorola	MZ500-15
CR19	Diode Si Ref 18.0V 750mW	35-035-001	Motorola	1N1515A
Q3,10,11	Tstr PNP Si	30-033-001	**	--
Q4,8,9,15	Tstr NPN Si	30-039-001	Sprague	TN53
Q5	Tstr PNP Si	30-086-001	RCA	2N4314

* obd = order by description

POWER SUPPLY B CONTINUED 04-117-506

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
⚠	Schematic Reference			
	Q3,10,11 - 30-038-001 changed	to 30-033-001	**	--

* obd = order by description

AMPLIFIER (A3) 04-117-507

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
R36,37	Res 47Ω 1/4W 10%	40-012-012	Allen-Bradley	CB4701
R29,30	Res Met Film 15Ω 3/4W 1% T-0	40-002-007	IRC	CCB obd
R26	Res Met Film 56.2Ω 3/4W 1% T-0	40-002-021	IRC	CCB obd
R22	Res Met Film 68.1Ω 3/4W 1% T-0	40-002-023	IRC	CCB obd
R20,28,38	Res Met Film 100Ω 3/4W 1% T-0	40-002-027	IRC	CCB obd
R5	Res Met Film 150Ω 3/4W 1% T-0	40-002-031	IRC	CCB obd
R25,34	Res Met Film 182Ω 3/4W 1% T-0	40-002-033	IRC	CCB obd
R16,18	Res Met Film 1K 3/4W 1% T-0	40-002-053	IRC	CCB obd
R7,11,15,23	Res Met Film 1.82K 3/4W 1% T-0	40-002-059	IRC	CCB obd
R9,14	Res Met Film 2.21K 3/4W 1% T-0	40-002-063	IRC	CCB obd
R12	Res Met Film 2.74K 3/4W 1% T-0	40-002-065	IRC	CCB obd
R4,24	Res Met Film 3.32K 3/4W 1% T-0	40-002-067	IRC	CCB obd
R8,10	Res Met Film 5.62K 3/4W 1% T-0	40-002-073	IRC	CCB obd
R32	Res Met Film 8.25K 3/4W 1% T-0	40-002-077	IRC	CCB obd
R2	Res Met Film 10K 3/4W 1% T-0	40-002-079	IRC	CCB obd
R17	Res Met Film 12.1K 3/4W 1% T-0	40-002-081	IRC	CCB obd
R6,13	Res Met Film 27.4K 3/4W 1% T-0	40-002-089	IRC	CCB obd
R35	Res Met Film 221K 3/4W 1% T-0	40-002-111	IRC	CCB obd
R27	Res Pwr 1K 15W 5%	40-221-001	Memcor	1-BRS-53B-B410
R3,33	Res WW 10K .33W 0.1% 7ppm/°C	40-187-002	Daven	1301 obd
R40	Res 3.9K 1/4W 5%	40-003-024	Allen-Bradley	CB3925
C2,4,5,9,11,14	Cap Cer .03μf 50V +80% -20%	45-902-002	Centralab	CK-303
C13	Cap Mica 10pf 300V	45-001-005	Electro-Motive	DM15C011H0300 WV4CR
C13A	Cap Var 0.8-8.5pf 1000V	45-510-003	Erie	563-013
C10	Cap Mica 180pf 300V 3%	45-003-013	Electro-Motive	DM15F181H0300 WV4CR
C3	Cap Mica 470pf 300V 3%	45-003-023	Electro-Motive	DM15F471H0300 WV4CR
C1	Cap Mica 1000pf 300V 3%	45-004-001	Electro-Motive	DM19F102H0300 WV4CR
C8	Cap Mica 2200pf 300V 3%	45-004-009	Electro-Motive	DM19F222H0300 WV4CR

* obd = order by description

AMPLIFIER (A3) CONTINUED 04-117-507

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
C12	Cap Mylar 0.1μf 200V 10%	45-108-501	Sprague	192P10492
CR1-3	Diode Si 200mA 120 PIV	35-001-001	Fairchild	1N658
CR4	Diode Si Ref 24V 400mW	35-051-025	Motorola	MZ500-25
Q7,5 ▲	Tstr PNP Si	30-033-001	**	--
Q6,8,11	Tstr NPN Si	30-039-001	Sprague	TN53
Q1-4	Tstr NPN Si	30-040-011	**	--
Q9	Tstr PNP Si	30-054-001	Motorola	2N3634
Q10	Tstr NPN Si	30-011-021	**	--
TP1	Test Jack P.C. Red	29-024-001	H.H.Smith	430-102 obd
HS1,2,3	Heat Sink Top Hat JEDEC Type TO-5	55-003-001	Wakefield Eng	207 obd
HS4	Heat Sink Top Hat JEDEC Type TO-5	55-003-002	Wakefield Eng	209 obd
▲	Schematic Reference			
	Q5 - 30-038-001 Changed to	30-033-001	**	--

* obd = order by description

SW1-B BOARD 04-117-517

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
R1,2,3,4	Res Met Film 47.5K 3/4W 1% T-0	40-002-095	IRC	CCB obd
R5	Res Met Film 1 Meg 3/4W 1% T-0	40-002-127	IRC	CCB obd
R6	Res Met Film 100K 3/4W 1% T-0	40-002-103	IRC	CCB obd
C2	Cap Ta 10µf 15V	45-409-003	Sprague	150D106X0015S2
C1	Cap Ta 100µf 20V	45-407-002	Sprague	150D107X0020S2
C4	Cap Mylar .15µf 200V 10%	45-110-501	Sprague	192P15492
C3	Cap Mylar 0.82µf 100V 20%	45-129-003	Elpac	ZD1X824
SW1-B	Sw Rot 2 P 5 Pos Shtg	35-063-002	**	-

* obd = order by description

SW1-C BOARD 04-117-517

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
R3,6	Res 6.8M 1/2W 5%	40-009-025	Allen-Bradley	EB6855
R1,4	Res Met Film 3/4W 1% T-0 68K	40-002-099	IRC	CCB obd
R2,5	Res Met Film 3/4W 1% T-0 680K	40-002-123	IRC	CCB obd
C14	Cap Mica 330pf 300V 2%	45-003-219	Electro-Motive	DM15F331H0300 WV4CR
C15	Cap Var .8-30pf 1kV	45-510-001	Erie	569-013
SW1-C	Sw Rot 2 P 5 Pos Shtg 5 Pos Non-Shtg	34-063-002	**	--
	Cap Trim Pkg	23-117-297-1	Weston	--
	Cap Trim Pkg	23-117-297-2	Weston	--
	Cap Trim Pkg	23-117-297-3	Weston	--

* obd = order by description

SW1-D BOARD 04-117-517

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
R3	Res 6.8M 1/2W 5%	40-009-025	Allen-Bradley	EB6855
R1	Res Met Film 68K 3/4W 1% T-0	40-002-099	IRC	CCB obd
R2	Res Met Film 680K 3/4W 1% T-0	40-002-123	IRC	CCB obd
R4	Res 150MΩ 1/2W 5%	40-009-028	Allen-Bradley	EB1565
R5	Res Met Film 15Ω 3/4W 1% T-0	40-002-007	IRC	CCB obd
R8	Res Met Film 18.2Ω 3/4W 1% T-0	40-002-009	IRC	CCB obd
R7	Res Met Film 33.2Ω 3/4W 1% T-0	40-002-015	IRC	CCB obd
R10	Res Var PC Type 500Ω 2W	40-418-006	Helipot	77PR500
C14	Cap Mica 330pf 300V 2%	45-003-219	Electro-Motive	DM15F331H0300 WV4CR
C15	Cap Var .8-30pf 2kV	45-510-001	Erie	569-013
C16	Cap Mica 1800pf 300V 3%	45-004-007	Electro-Motive	DM19F182H0300 WV4CR
SW1-D	Sw Rot 2 P 5 Pos Shtg 5 Pos Non-Shtg	34-063-002	**	--
	Cap Trim Pkg	23-117-297-1	Weston	--
	Cap Trim Pkg	23-117-297-2	Weston	--
	Cap Trim Pkg	23-117-297-3	Weston	--

* obd = order by description

SW1-E BOARD 04-117-517

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
R4	Res Met Film 10K 3/4W 1% T-0	40-002-079	IRC	CCB obd
R2	Res Met Film 6.81K 3/4W 1% T-0	40-002-075	IRC	CCB obd
R6	Res Met Film 8.25K 3/4W 1% T-0	40-002-077	IRC	CCB obd
R8	Res Met Film 5.62K 3/4W 1% T-0	40-002-073	IRC	CCB obd
R1,3,5,7	Res Met Film 100K 3/4W 1% T-0	40-002-103	IRC	CCB obd
C8	Cap Mica 4700pf 300V 3%	45-005-001	Electro-Motive	DM20F472H0300 WV4CR
C6,7	Cap Mylar .047µf 100V 20%	45-129-001	Elpac	ZD1X473
C4,5	Cap Mylar .47µf 100V 20%	45-129-002	Elpac	ZD1X474
C2	Cap Mylar 4µf 100V 20%	45-122-101	TRW	X663F40501W
C3	Cap Mylar 5µf 100V 20%	45-122-102	TRW	X663F50501W
C1A,B,C,D	Cap Mylar 10µf 100V 20%	45-122-103	TRW	X663F10601W
SW1-E	Sw Rot 2 P 5 Pos Shtg 5 Pos Non-Shtg	34-063-002	**	--

* obd = order by description

BACKBOARD 04-117-517

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
R25	Res Met Film 100K 3/4W 1% T-0	40-002-103	IRC	CCB obd
R3,7	Res Var 50Ω 1/2W	40-406-003	Helipot	62PR50
R2,11	Res Var 500Ω 1/2W	40-406-006	Helipot	62PR500
R1	Res Met Film 82K 3/4W 1% T-0	40-002-101	IRC	CCB obd
R26,27	Res Met Film 10K 3/4W 1% T-0	40-002-079	IRC	CCB obd
J1	Conn Male 29 Pin	29-032-129	Elco	00-7023-029-000-001
J6	Conn Female 32 Pin	29-033-132	Amphenol	26-4200-32S
C7,8	Cap Cmptr Gr 1300µf 100V low screw	45-221-451	Mallory	CG132U100H1
C1,2,3,4,5,6	Cap Cmptr Gr 2600µf 50V	45-218-352	Sprague	36D2626050AB2A
C9,C9A,C10,C10A	Cap Ta 22µf 50V	45-418-001	Sprague	150D226X0050S2

* obd = order by description

OPTION 05

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
External Sync.	Assy A4 Option 05 Board	14-117-087	Weston-Lex.	Reference
	Mach A4 Option 05 Board	13-117-086	Weston-Lex.	Reference
C1,2	Cap Ta 47µf 20V 20%	45-407-001	Sprague	150D476X0020S2
CR1,2	Diode Si Ref 10V 400mW	35-051-016	Motorola	MZ500-16
R1,5	Res Met Film 6.81K 3/4W 1% T-0	40-002-075	IRC	CCB obd
R2	Res Met Film 1.82K 3/4W 1% T-0	40-002-059	IRC	CCB obd
R3	Res Met Film 8.25K 3/4W 1% T-0	40-002-077	IRC	CCB obd
R4	Res Met Film 825Ω 3/4W 1% T-0	40-002-051	IRC	CCB obd
	REAR PANEL			
	Cover Plant Type II	08-117-425	Weston-Lex.	Reference
XF2	Fuseholder	33-001-001	Littlefuse	34 2012
F2	Fuse 1/32 Amp	33-011-006	Buss	AGC obd
S4	Sw S1 3 P DBL Throw	34-062-004	Stackpole	SS-34

* obd = order by description

MANUFACTURERS FEDERAL SUPPLY CODE NUMBER

MANUFACTURER	ADDRESS	FEDERAL SUPPLY CODE
Allen-Bradley Co.	Milwaukee, Wisc.	19615
Amphenol Connector Div.	Broadview, Ill.	02660
Bussman Manufacturing Div.	St. Louis, Mo.	71400
Centralab, Inc.	Chicago, Ill.	71365
CTS Corporation	Elkhart, Indiana	71450
Dage Electric Co. Inc.	Franklin, Ind.	95712
Daven Div., McGraw-Edison	Milwaukee, Wisc.	36375
Elco Corp.	Willow Grove, Pa.	91662
Electro-Motive Mfg. Co. Inc.	Willimantic, Conn.	72136
Elpac Components Div.	Newport Beach, Calif.	92660
Erie Tech. Prods. Inc.	Erie, Pa.	71982
Fairchild Electro-Metrics	Amsterdam, N.Y.	18581
General Electric Co. Capacitor Dept.	Hudson Falls, N.Y.	01002
General Electric Co. Lamp Div.	Nela Park, Ohio	24455
Helipot Div., Beckman Instruments Inc.	Fullerton, Calif.	30646
IMC Magnetics Corp.	Maywood, Calif.	99743
IRC, Div TRW Inc.	Philadelphia, Pa	75042
Klixon Div., Texas Instruments Inc. Control Products Div.	Attleboro, Mass.	82647
Littlefuse Inc.	Des Plaines, Ill.	75915
Mallory Capacitor Co. Div. P.R. Mallory & Co. Inc.	Indianapolis, Ind.	37942
Marco-Oak, Div. Electro/Netic Corp.	Anaheim. Calif.	87034
Memcor Div., LTV Electro Systems	Hunington, Ind.	73978
Motorola Semiconductor Products Inc.	Phoenix, Ariz.	04713
Radio Corp of America	Somerville. N.J.	02735
Sprague Electric Co.	N. Adams, Mass	56289

MANUFACTURER	ADDRESS	FEDERAL SUPPLY CODE
Stackpole Electrical/ Mechanical Products Div.	St. Mary's, Pa.	05371
Texas Instruments Inc. Semiconductor Components Div.	Dallas, Texas	01295
TRW Thompson Ramo Wooldridge Inc.	Ogallala, Neb.	84411
Tower Mfg. Corp.	Providence, R.I.	87930
Vishay Resistor Prod. Div. Vishay Intertechology	Malvern, Pa.	18612
Wakefield Engr. Inc.	Wakefield, Mass.	05820
Ward Leonard Electric Co.	Mt. Vernon, N.Y.	63743
Weston Instruments Inc.	Lexington, Mass.	11842
H.H. Smith	Brooklyn, N. Y.	Not Listed

Serial Number_____

OPERATING AND SERVICE MANUAL

MODEL 111PM

VOLTAGE DIVIDER (MILITARIZED)

Serial Numbers 001-023

Contract No. DAAH01-69-C-1367

WESTON-LEXINGTON
Weston Instruments Division
17 Hartwell Avenue
Lexington, Massachusetts 02173

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W A R R A N T Y

Weston-Lexington warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this Warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose, and to replace any defective parts thereof. This Warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed to the customer. In this case, an estimate will be submitted before the work is started.

IN ANY FAULT DEVELOPS, THE FOLLOWING STEPS SHOULD BE TAKEN:

1. Notify us giving full details of the difficulty; include the Model number and serial number. On receipt of this information, we will give you service data or shipping instructions.
2. On receipt of shipping instructions, forward the instrument prepaid to the factory or to the authorized repair station indicated on the instructions. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SECTION 1

DESCRIPTION AND SPECIFICATIONS

1.1. GENERAL DESCRIPTION

The Model 111 plug-in is a high-resolution voltage divider providing good accuracy and exceptional frequency response when used with the Weston 100 series Precision Oscillators at a constant 200Ω output impedance over the frequency range from 10Hz to 100kHz. The plug-in consists of a three-decade plus vernier wide-band voltage divider which divides the output of the oscillator from 0 to 12 volts over four multiplier ranges. Complete specifications are given in Section 1.3. The decade divider has settings from 0.00 to 12.10 (11.XX) with a continuously variable vernier covering 0.000 to 0.00X. The four multiplier ranges are X1, X0.1, X0.01 and X0.001. Resolution of better than one microvolt is available on the X0.001 multiplier range with the vernier covering the range from 0 to 10 microvolts. A floating output connector is included which isolates the divider circuit ground from the chassis ground and allows for floating operation when the oscillator switch is in the floating position. (See 100 series oscillator manual for floating operation.)

1.2. USES

Flat frequency-response, constant output-impedance, high resolution, and accuracy make the combination of the Model 111 plug-in and Weston Precision Oscillator useful in such applications as frequency-response testing from 1mV to 12 volts, distortion analysis, and measuring the gain of an amplifier or system. With the fixed high-level reference output available from the basic oscillator and Model 111 plug-in providing low-level

signals, suppressed-carrier systems which utilize phase-sensitive demodulators can be easily evaluated. With a quadrature reference also available from the oscillator, quadrature rejection of phase-sensitive systems can also be analyzed.

1.3. SPECIFICATIONS

Numbers in parentheses following headings refer to the applicable paragraph numbers in specification MIS-10272A as ammended 12 February 1969.

Controls: 4 decade divider with a X1, X0.1, X0.01 and X0.001 range multiplier which provides 1 microvolt per division in the X0.001 multiplier position. 4th decade is a potentiometer.

Output Voltage Settings: (3.3.8)
0 to 12.11 volts (X1 range)
0 to 1.211 volts (X0.1 range)
0 to 0.1211 volts (X0.01 range)
0 to 0.01211 volts (X0.001 range)

Total Frequency Response (resistive loads) Including Oscillator (referenced to 400Hz)

Range Position	10Hz-20Hz	20Hz-20kHz	20kHz-50kHz	50kHz-100kHz
X1‡	0.02% ±0.1mV	0.01% ±0.15mV	0.02% ±0.2mV	0.05% ±0.3mV
X0.1‡	0.02% ±20μV	0.01% ±20μV	0.05% ±30μV	0.07% ±50μV
X0.01‡	0.02% ±2μV	0.02% ±2μV	0.07% ±10μV	0.1% ±20μV
X0.001	0.02% ±1μV	0.05% ±1μV	0.1% ±3μV	0.15% ±5μV

Accuracy at 400Hz‡: ±0.25% X1 range
±0.35% X0.1 range
±0.45% X0.01 range
±0.55% X0.001 range

Harmonic Distortion: Same as Precision Oscillator specifications, for linear loads.

‡With first digit not set to zero

Amplitude Stability Vs. Temperature±(total including oscillator):	±0.03%/°C
Output Impedance: (3.3.11)	200Ω ±0.2%
Available Output Current:	Matched 200Ω load; 30mA max. *Short circuit load; 60mA max.
Maximum Input Current to Plug-In:*	1) No load on plug-in: 23mA in X1, 27mA in X0.1, X0.01 and X0.001. 2) Matched 200Ω load: 47mA. 3) Plug-in "short circuit" load, 9V setting and below: 55mA. 4) *Plug-in "short circuit" load; above 9V setting: 78mA.
Connector (3.2.5):	Front Panel BNC output connector.
Temperature Range for Specified Performance (3.4.1a):	+4°C to +40°C
Operating Temperature Range:	0° to +52°C
Operating Relative Humidity Range for Specified Performance (3.4.1b):	0-90%
Operating Altitude Range for Specified Performance (3.4.1c):	0 - 10,000 ft.
Front Panel Finish (3.2.1):	Finished in accordance with manufacturing procedures which are compatible with the requirements of MIL STD-171.

*Current available from Precision Oscillator front panel fixed output in mA equals 60 less plug-in input current. If the input current to the plug-in exceeds 60mA, distortion and frequency response will be slightly degraded due to overloading the oscillator.

Calibration and Reliability: (3.3.14)	The Plug-in unit will perform without recalibration or readjustment for a minimum of 180 days, 120 of these may be 8 hour continuous operation days.
Non-Operational Environment: (3.4.2.)	The equipment shall operate as specified after being subjected to the following conditions and returned to normal ambient conditions. No damage or performance degradation shall result from these conditions. a. Stored for 48 hours at minus 55 degrees Centigrade. b. Stored for 48 hours at plus 60 degrees Centigrade. c. Stored for 12 hours at 40,000 feet above sea level.
Vibration (3.4.3):	The unit shall be capable of withstanding a vibration test with the frequency varying from 10 to 55 cycles per second at a total excursion of 0.01 plus 0.006 inches or minus 0.000 and returning to 10 cycles per second in approximately 5 minutes in each of the three major axis. No damage or performance degradation shall result from this test.
Vertical and Lateral Shock (3.4.4):	The unit shall be capable of withstanding vertical and lateral shock of 15 gravity units half sine for 11 milliseconds. No damage or performance degradation shall result from this test.

Tilt Drop (3.4.5):	The equipment shall be capable of operating satisfactorily without permanent damage or degradation of accuracy after being subjected to a tilt drop test. This test will be performed by raising each of the four sides of the unit, using the opposite side as a pivot, at least four inches above the horizontal plane and allowing the unit to drop freely onto a solid surface. No damage or performance degradation shall result from this test.
General Requirements: (3.5)	General requirements shall be in accordance with MIL-STD-454, requirements 1, 5A, 7A, 8A, and 9.
Dimensions and Weight:	4-1/8" h x 5-3/16" w x 5-9/16" d behind front panel (excluding connector); 2-1/2 lbs.

SECTION 2

INSTALLATION AND OPERATION

2.1. INSTALLATION

The plug-in module has been designed to fit into the front panel receptacle on the Precision Oscillator (see Precision Oscillator manual). Before inserting plug-in into the receptacle, place plug-in locking latch (see Figure 2-1) in a position such that the plug-in will slide completely into the receptacle. When fully inserted, the front panel of the plug-in should be flush with the oscillator front panel. Turn locking latch in the clockwise direction to lock the plug-in firmly in place.

2.2. OPERATING CONSIDERATIONS

2.2.1. OUTPUT IMPEDANCE

For full accuracy and ease of application, the load impedance should be as high as possible (greater than 400KΩ). The divider itself is calibrated for no load. With a matched 200Ω load, the output voltage will be half the indicated value. For any load (R_L), the output voltage equals:

$$\text{Divider output} = \frac{R_L}{R_L + 200} \times \text{dial setting}$$

where R_L is in ohms.

2.2.2. PLUG-IN CURRENT DRAIN WITH LOAD

The output amplifiers in the oscillator are rated at 60mA maximum for full specification. Because their outputs are brought directly to the front panel of the oscillator at a low impedance level, it is possible to draw more than 60mA. Although

this does not harm the amplifiers in any way, the oscillator specifications are no longer maintained. When a divider plug-in is being driven by the amplifiers, the total current available at the low impedance front-panel outputs is reduced by the amount used by the plug-in. The currents for different loads on the divider must be subtracted from the specified 60mA level to determine how much current is still available from the zero impedance output. For the Model 111PM plug-in, only phase A is used, allowing phase B low-impedance oscillator front-panel output to supply 60mA regardless of the load on the divider output. (See specifications, Section 1.3., for input current for different loads).

2.2.3. CAPACITIVE LOADING

A capacitive load on the divider will affect the frequency response of the output voltage from the divider. With capacitive loading, the following formula should be used to calculate additional frequency-response error:

$$\text{Additional \% error} \approx 0.78 f^2 \times 10^{-10} \left[(C_{ext} + 50)^2 - (50)^2 \right]$$

where: C_{ext} is in pf

f is in kHz

2.3. OPERATING PROCEDURE

a. Insert plug-in into oscillator receptacle on front panel (see Section 2.1.).

NOTE: The oscillator need not be turned off when plug-ins are inserted or removed.

b. Set dials and multiplier switch to the desired voltage (see Section 2.2.1. for heavy loads).

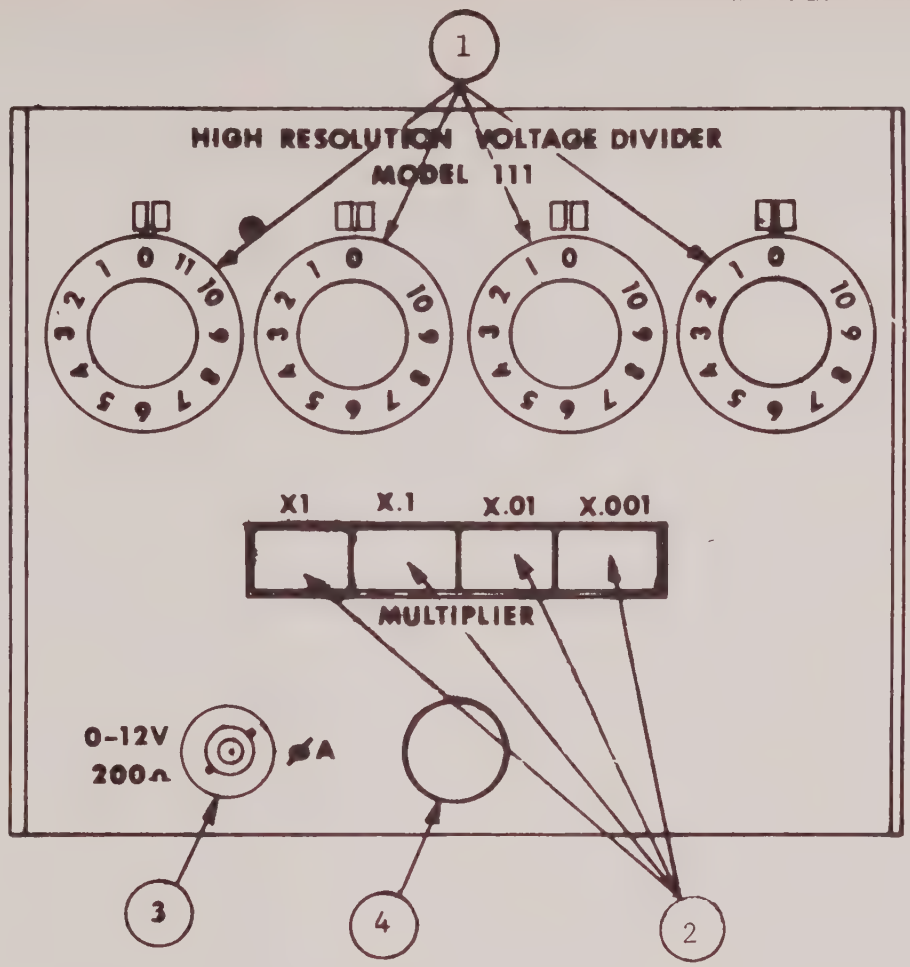
c. Attach load to the output connector on the front of the plug-in.

2.4. IMPEDANCE ADAPTORS

Some loads are affected by an impedance mismatch, or frequency response may be degraded due to large capacitive loads. For such cases, impedance adaptors may be necessary. The following is a list of adaptors and their part numbers which are available as accessories:

200Ω to 600Ω adaptor - Weston Part No. 02-117-308

200Ω to 50Ω X10 attenuator - Weston Part No. 02-117-207



1. DIVIDER SWITCHES AND VERNIER (SW10, 11, 12 and R134) divides Precision Oscillator phase A output from 12.10 volt to 1μV when used in conjunction with the multiplier ranges.

2. MULTIPLIER RANGES (SW13, 14, 15 and 16) provide multiplication of divider switches by X1, X0.1, X0.01 and X0.001.

3. OUTPUT (J111) attenuated phase A output of Precision Oscillator.

4. PLUG-IN LOCKING LATCH, turn fully counter-clockwise to insert or remove plug-in, fully clockwise to lock plug-in into oscillator.

Figure 2-1. Front Panel Controls and Connectors

SECTION 3

THEORY OF OPERATION

The Model 111 plug-in is shown in simplified form in Figure 3-1, below.

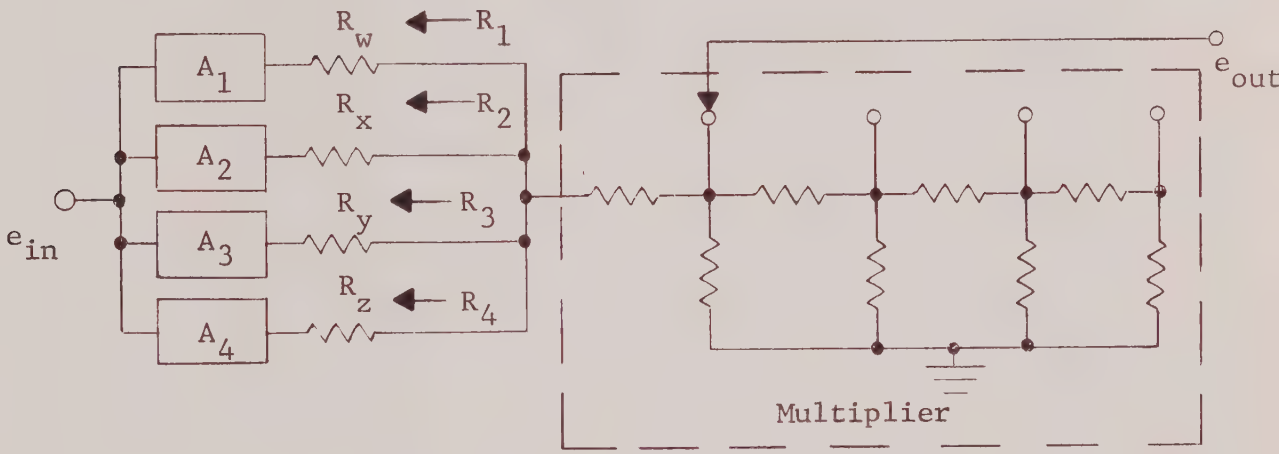


Figure 3-1
Simplified Schematic

Most precision dividers (Kelvin-Varley, etc.) yield fine ratio accuracies, but output impedance varies with setting. This change in loading is not desirable as it seriously affects voltage accuracy under load.

In Figure 3-1, A_1 represents a switched potentiometer. Different resistors are selected for each switch position such that R_1 is held constant with switch setting (see Schematic 04-117-511-1). A_2 and A_3 are similar to A_1 except that R_x and R_y must also act as weighting resistors such that the full-scale effect of A_2 is 1/12 A_1 and the full-scale effect of A_3 is 1/10 A_2. A_4 is a true potentiometer whose weighting resistor R_z is large

enough to make R_4 essentially constant with potentiometer setting. With this weighting resistor, the full-scale effect of A_4 is 1/1200 of A_1.

The total effect of A_1, A_2, A_3 and A_4 plus their associated resistors is a linear continuously-adjustable divider with constant (±0.2%) output impedance. The multiplier is a simple ladder attenuator with a high degree of shielding between input and output to maintain the frequency response of the divider to low voltage setting. There is, however, still some feedthrough capacitance from input to output at low divider settings and at high frequencies which has been drastically reduced by additional compensation circuitry. Figure 3-2 shows in block diagram form the technique used to reduce this effect. In Figure 3-2, an equal but opposite amount of the signal current is generated by a source which is exactly 180° out of phase with the divider input source. The net result is a drastic reduction in the error caused by the feedthrough capacitance.

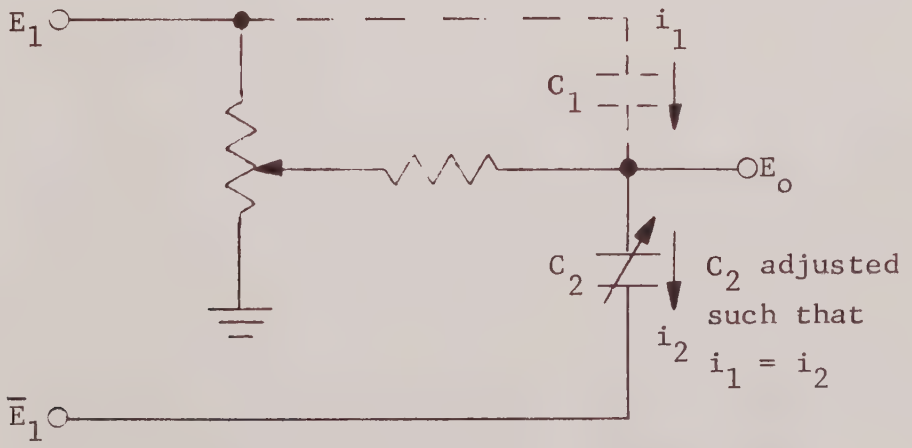


Figure 3-2

Feedthrough Compensation

SECTION 4

MAINTENANCE AND CALIBRATION

This section contains maintenance and calibration information for the model 111PM High Resolution Voltage Divider Plug-In. It is organized under three headings: performance tests (4.1), calibration procedure (4.2) and troubleshooting and repair (4.3).

4.1 PERFORMANCE TESTS

The performance tests are used to verify that the model 111PM Plug-In is operating within its specifications. These tests may be used for initial qualification testing or for periodic maintenance purposes. The required test equipment is listed in Figure 4-1. If the voltage divider fails any of these tests, refer to the calibration procedures in section 4.2.

4.1.1 VOLTAGE ACCURACY TEST

This test is used to check the accuracy and linearity of the range multipliers and decade voltage controls. Since few ac voltmeters are accurate enough for this test, a dc digital voltmeter is used, while the input is driven by an accurate dc voltage source, as indicated in Figure 4-2.

4.1.2 RESIDUAL FEEDTHRU TEST

This test is used to check for the residual signal feedthrough on each range when all of the decade controls and the vernier are set to zero. The specified frequency response at the lower voltage settings on each range is possible only by maintaining very low residuals.

4.1.3. FREQUENCY RESPONSE

The frequency response of the model 111PM Voltage Divider effectively depends upon stray coupling within the unit, which is determined by the geometrical placement of components. The design has been carefully checked using special equipment which is not often available in calibration laboratories. Since the critical placement of components is controlled by the printed circuits used throughout, the frequency response will not change over the life of the equipment. Some users will want to perform an initial acceptance test on the unit; therefore, the frequency response test shown in Figure 4-4 has been included.

Extremely stable, wideband measurement equipment is required. While the new NBS type "F" coaxial thermal converters are easier to use because of their improved stability, the older type "C" High-Frequency thermal converter will perform satisfactorily. Since the "middle" position on each decade represents the maximum internal impedance level and therefore the "worst-case" frequency response, these tests are performed at a voltage setting of 6.550V. Because we are only interested in the relative frequency response, the decrease in output voltage due to thermal converter loading is inconsequential. For the higher frequency measurements, allowance must be provided for the additional capacitive loading errors due to any cable and thermal converter input capacitance.

If additional test data is required, the 2.5ma thermoelement alone can be used to measure the 1 volt frequency response at 1.000 (X1) or 10.000 (X.1). Measurements at lower voltages are not recommended since they are extremely difficult to perform, requiring the use of a Selby-type micropotentiometer to calibrate a sensitive, well-shielded, low-level ac digital voltmeter.

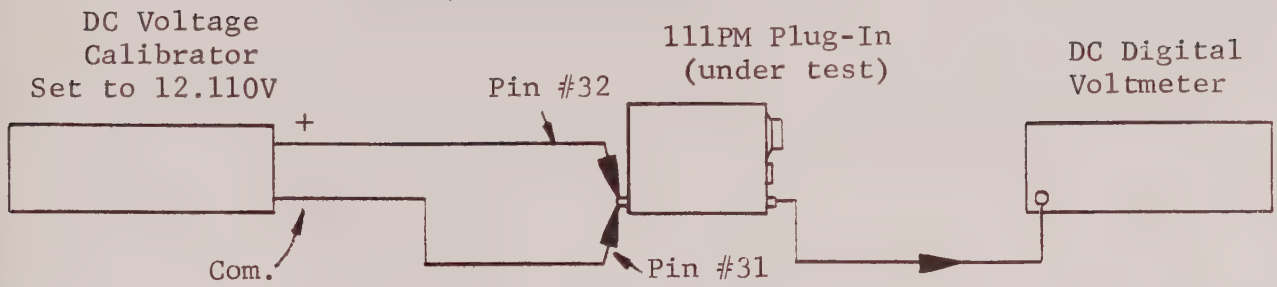
Figure 4-1

REQUIRED EQUIPMENT FOR PERFORMANCE TESTS
AND CALIBRATION ADJUSTMENTS

Description	Used in Fig.	Characteristics	Recommended Manufacturer/Model
DC Voltage Calibrator	4-2, 4-5	.01% accuracy 12.110V output	Fluke models 332B or 343
DC Digital Voltmeter	4-2 4-5	.01% accuracy, 1 and 10 volt ranges	Dana model 5500, or equivalent
AC Milli-voltmeter	4-3	100μV sensitivity	Hewlett Packard model 427, or equivalent
(Optional) Coaxial High Frequency thermal converter with ancillary equipment (Lindeck potentiometer and galvanometer)	4-4	NBS type "F". Refer to paper "Thermal Converters for Audio-Frequency Voltage Measurements of High Accuracy", IEEE Transactions on Instrumentation and Measurement, Dec. 1966.	Holt Instrument Labs model 11

Figure 4-2

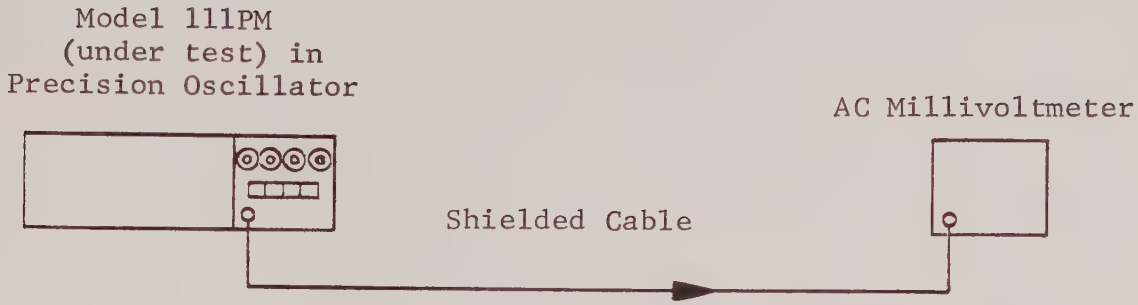
VOLTAGE ACCURACY TEST



Voltage Setting		Allowable Limits
Decades +(Vernier)	Range	
10.00(0)	X1	9.9750 to 10.0250 V
"	X.1	.99650 to 1.00350V
"	X.01	.09955 to .10045V
"	X.001	.00994 to .01006V
1.00(0)	X1	.9974 to 1.0025 V
2.00(0)	"	1.9950 to 2.0050 V
3.00(0)	"	2.9950 to 3.0075 V
4.00(0)	"	3.9800 to 4.0100 V
5.00(0)	"	4.9875 to 5.0125 V
6.00(0)	"	5.9850 to 6.0150 V
7.00(0)	"	6.9825 to 7.0175 V
8.00(0)	"	7.9800 to 8.0200 V
9.00(0)	"	8.9775 to 9.0225 V
11.00(0)	"	10.9725 to 11.0275 V
1.10(0)	X1	1.0972 to 1.1028 V
1.20(0)	"	1.1970 to 1.2030 V
1.30(0)	"	1.2968 to 1.3032 V
1.40(0)	"	1.3965 to 1.4035 V
1.50(0)	"	1.4962 to 1.5038 V
1.60(0)	"	1.5960 to 1.6040 V
1.70(0)	"	1.6957 to 1.7043 V
1.80(0)	"	1.7955 to 1.8045 V
1.90(0)	"	1.8952 to 1.9053 V
1.X0(0)	"	1.9950 to 2.0050 V
1.03(0)	X1	1.0274 to 1.0326 V
1.05(0)	"	1.0474 to 1.0526 V
1.07(0)	"	1.0673 to 1.0727 V
1.0X(0)	"	1.0972 to 1.1028 V
1.00(X)	"	1.0075 to 1.0125 V

Figure 4-3

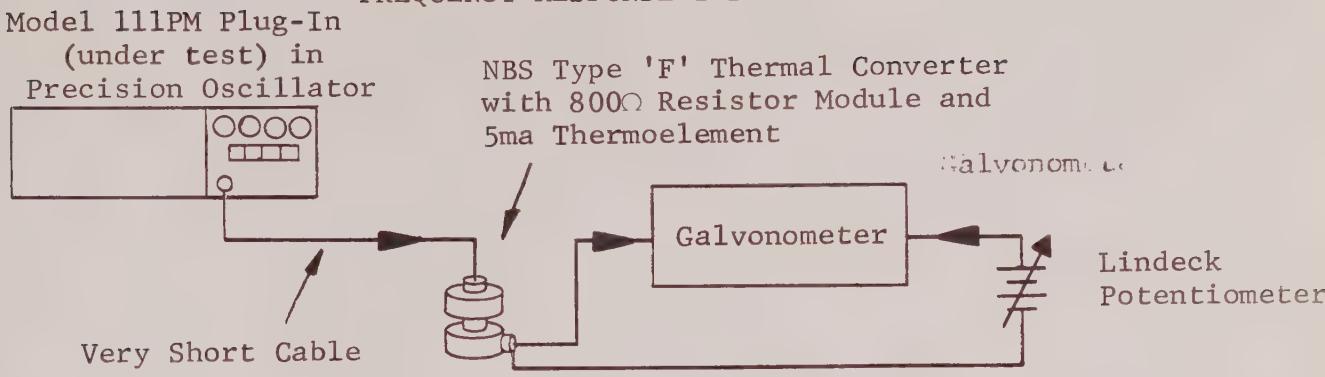
RESIDUAL FEEDTHROUGH TEST



Oscillator Frequency Setting	Voltage Setting		Allowable Limits
	Decades + (Vernier)	Range	
100kHz	0.00(0)	X1	100μV maximum

Figure 4-4

FREQUENCY RESPONSE TEST



Procedure	Allowable Limits
Set the oscillator frequency controls for 400Hz. Set the Voltage Divider Controls for 6.550V (X1 range). Connect the thermal converter and allow 30 minutes warmup time. Adjust the Lindeck potentiometer for a galvanometer null. Change the frequency dail setting to 1 and the multiplier to X10. Record the galvanometer deflection and the corresponding percentage frequency-response of this 10Hz point relative to the 400Hz reference frequency. Recheck the 400Hz null condition.	Output amplitude at 10Hz must be within ±0.02% ±0.1mV of that at 400Hz.
Repeat this procedure for the frequency response of 20Hz relative to 400Hz.	20Hz frequency response: ±(0.01% +0.1mV) max.
Repeat this procedure for the frequency response of 100Hz (X10 range) relative to 400Hz.	100Hz frequency response: ±(0.01% +0.15mV) max.
Repeat this procedure for the frequency response of 1000Hz (X100 range) relative to 400Hz.	1000Hz frequency response: ±(0.01% +0.15mV) - CLE* max.
Repeat this procedure for the frequency response of 10kHz (X1k range) relative to 400Hz.	10kHz frequency response: ±(0.01% +0.15mV) - CLE* max.
Repeat this procedure for the frequency response of 50kHz relative to 400Hz.	50kHz frequency response: ±(0.02% +0.2mV) - CLE* max.
Repeat this procedure for the frequency of 100kHz relative to 400Hz.	100kHz frequency response: ±(0.05% +0.3mV) - CLE* max.

*CLE = Capacitive Loading Error due to cable and thermal converter input capacitance; calculate using formula in paragraph 2.2.3.

4.2. CALIBRATION ADJUSTMENT PROCEDURE

Figure 4-5 describes all of the calibration adjustments which should be necessary to maintain the model 111PM Voltage Divider within its performance specifications. The plug-in should not require readjustment any more frequently than once per year. The test equipment requirements have been included in Figure 4-1.

Figure 4-5

CALIBRATION ADJUSTMENTS

Required test equipment is included in Figure 4-1. Refer to drawing 04-117-511-B for the location of all adjustments.

Adjustment	Circuit Designator	Test Circuit	Procedure
1 volt	R13	Fig. 4-2	Set controls to 1.000 (X1); adjust for output voltage between 0.9985 and 1.0015V.
2 volt	R11	Fig. 4-2	Set controls to 2.000 (X1); adjust for output voltage between 1.9970 and 2.0030V. Recheck the 1 volt trim.
X.1 range	R87	Fig. 4-2	Set controls to 10.000 (X.1); adjust for output voltage between .99800 and 1.00200V.
X.01 range	R92	Fig. 4-2	Set controls to 10.000 (X.01); adjust for output voltage between .09970 and .10030V.
X.001 range	R92	Fig. 4-2	Set controls to 10.000 (X.001); adjust for output voltage between .00996 and .01004V.
"Zero Feedthru"	C2	Fig. 4-3	Set Oscillator to 100kHz. Set voltage controls to 0.000 (X1). Adjust for an output voltage of 100μV or less.

4.3. TROUBLESHOOTING AND REPAIR

Since the model 111PM Voltage Divider Plug-In contains only passive circuits, consisting mainly of high-reliability metal film resistors and switches, catastrophic electrical failure is unlikely. By applying a drop of "switch cleaner" to each rotary switch deck about once a year, the life of the switch contacts can be prolonged for many years of normal operation.

If the output voltage of the model 111PM disappears entirely, first check for the proper excitation voltage on the Precision Oscillator ØA front panel connector, before attempting to troubleshoot the plug-in.

If the output voltage is somewhat inaccurate at several points, the calibration adjustment procedure given in Figure 4-4 will often correct the problem. However, if the errors observed are greater than a few percent, a circuit failure is probable.

In order to isolate the faulty section of the circuit, perform the complete voltage accuracy test given in Figure 4-2. If the Plug-in fails the second through the fourth tests (but passes all other tests) then malfunctioning of the range attenuator pushbutton assembly is indicated. The remaining tests in Figure 4-2 check each individual decade for proper operation. Using the schematic diagram (section 5) in conjunction with the theory of operation(section 3), any defective components can be identified and replaced.

4.3.1. DISASSEMBLY FOR REPAIR

Depending upon the location of the faulty component, follow the appropriate procedure listed.

Board 7: Remove only the screws which mount the rear panel of the plug-in and bend leads for access to printed circuit board.

Boards 5 or 6: Detach rear panel of plug-in; cut the four jumpers between boards 5 and 6 (clean the eyelets and replace these jumpers when reassembling); remove the four screws which mount the printed circuits to the frame; remove the four screws which retain board #5, and move the board 6-7 assembly back for access.

Range switch assembly: Remove top or bottom shield cover, disconnecting feedthrough leads if necessary.

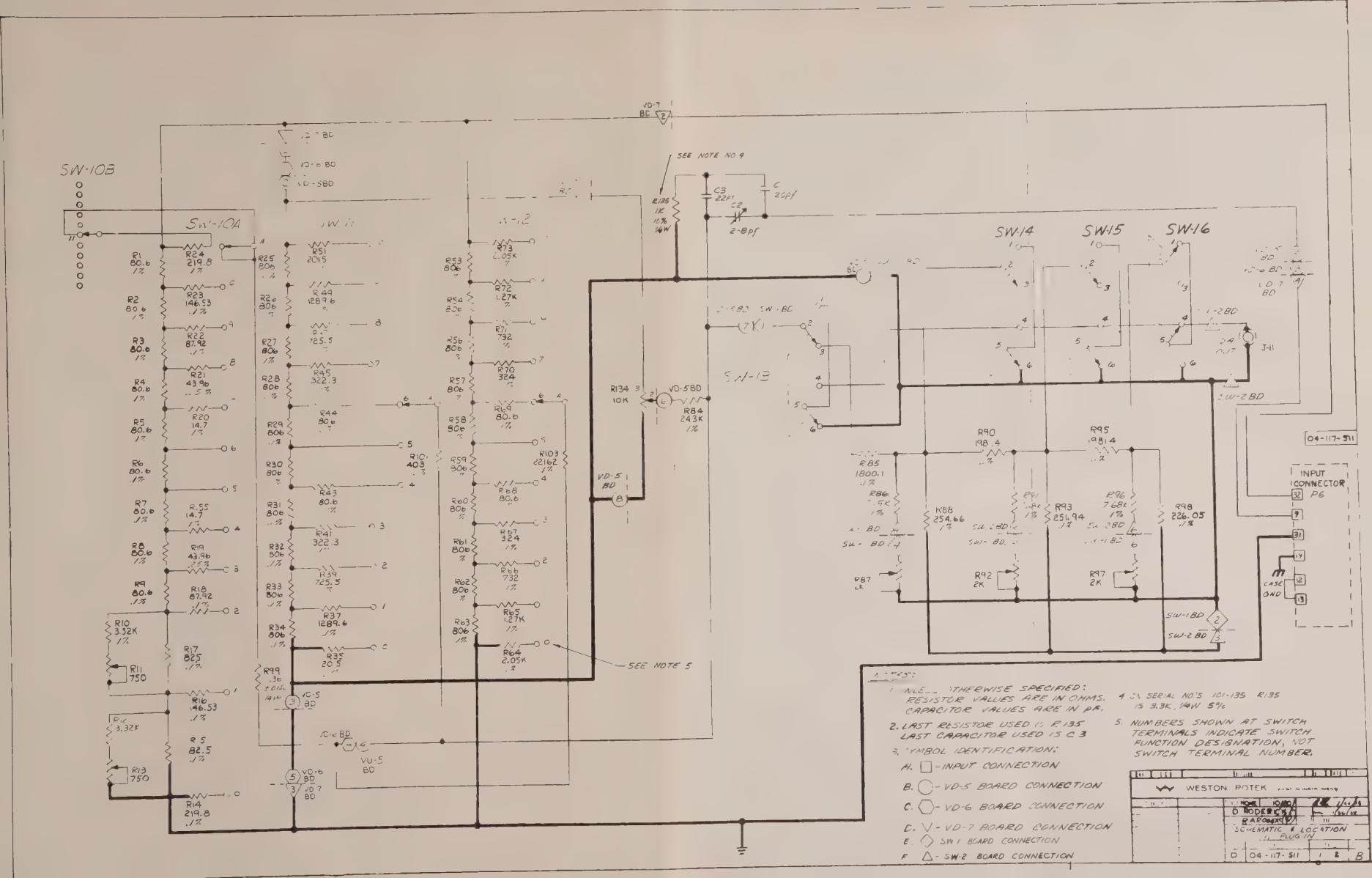
SECTION 5

CIRCUIT AND LOCATION DIAGRAMS

This section contains the overall schematic and location diagrams for the Model 111 Voltage Divider. The schematic is an overall schematic of the plug-in, and when used in conjunction with the Theory of Operation (Section 3.), should aid in understanding full operation of the plug-in.

Following is a list of the diagrams included in this section:

Number	Title
04-117-511-1	Schematic, 111 Plug-In
04-117-511-2	Location, 111 Plug-In



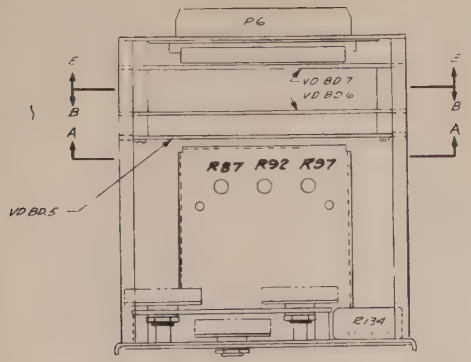
NOTES:

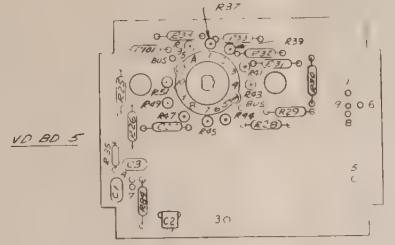
1. UNLESS OTHERWISE SPECIFIED: RESISTOR VALUES ARE IN OHMS. CAPACITOR VALUES ARE IN pf.
2. LAST RESISTOR USED IS R135 LAST CAPACITOR USED IS C3
3. SYMBOL IDENTIFICATION:
   - A. □ - INPUT CONNECTION
   - B. ○ - VD-5 BOARD CONNECTION
   - C. ⬡ - VD-6 BOARD CONNECTION
   - D. ▽ - VD-7 BOARD CONNECTION
   - E. ◇ - SW-1 BOARD CONNECTION
   - F. △ - SW-2 BOARD CONNECTION
4. ON SERIAL NO'S 101-135 R135 IS 3.3K, 1/4W 5%
5. NUMBERS SHOWN AT SWITCH TERMINALS INDICATE SWITCH FUNCTION DESIGNATION, NOT SWITCH TERMINAL NUMBER.

WESTON ROTEK

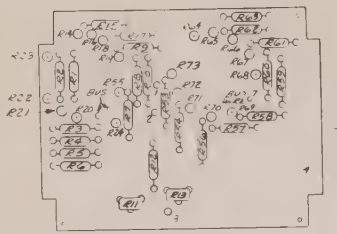
SCHEMATIC & LOCATION PLUG IN

04-117-511 1 2 B

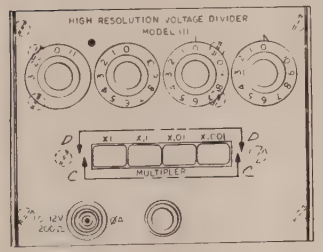


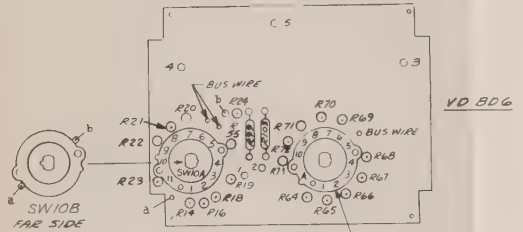


VIEW A-A

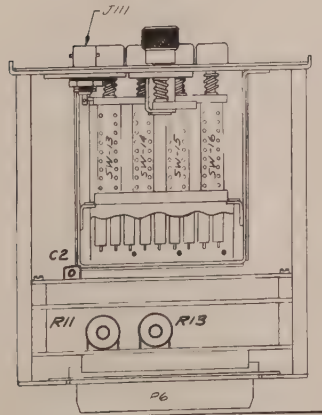


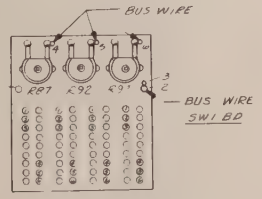
VIEW E-E



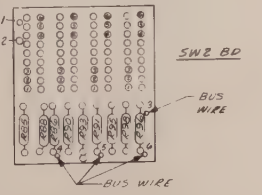


VIEW B-B





VIEW D-D
SHOWN WITH COVER REMOVED



VIEW C-C
SHOWN WITH COVER REMOVED

REF B M NONE

WESTON INSTRUMENTS INC
LEXINGTON DIVISION LEXINGTON MASS

SCHEMATIC & LOCATION
111 PLUG-IN

UNLESS OTHERWISE SPECIFIED - DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ± 1/64 DECIMALS .XX ± .03 .XXX ± .005 ANGLES ± 1/2° BENDS 90° FABRICATE PER SPEC 89 002 000

CONTRACT
AUTHENTICATION
DRAWN
CHK
REVIEW
ENGR
APPR
WESTON ROTER

MATERIAL -
APPEARANCE -
FINISH -
NEXT ASSY
APPLICATION
USED ON
REF SPECS

SIZE D | CODE IDENT NO 11842 | DRAWING NO 04-117-511-B
SCALE NONE | UNIT WT | SHEET 2 OF 2

SECTION 6

REPLACEABLE PARTS

This section contains ordering information for replacement parts listed by assembly and model. Where manufacturer and type are not given (designated by **), parts may be ordered directly from Weston-Lexington. These parts should be identified by Weston-Lexington part number; the instrument model number and serial number should also be specified.

Following is a list of assemblies included in this section:

Name	Page
Main Assembly	6-2
Switch Board 1	6-3
Switch Board 2	6-4
Voltage Divider Board 5	6-5
Voltage Divider Board 6	6-6
Voltage Divider Board 7	6-7
Manufacturers Federal Supply Code	6-8

MAIN ASSEMBLY 04-117-511

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
	Panel Frt	08-117-161	Weston	--
	Knob Extractor	03-117-200	Weston	--
	Latch Panel	07-117-377	**	--
	Insul Conn BNC	08-117-366	Weston	--
	Plate Rear	03-117-367	Weston	--
	Knob Frt Panel	08-117-372-1	**	
	Knob Frt Panel	08-117-372-5	**	
P6	Conn Male 32 Pin	29-033-232	Amphenol	26-4100-32P
J111	Conn Recp BNC	29-057-001	Amphenol	31-105
SW10	Sw Detent & Shaft	34-063-999-9	**	--
SW12	Sw Detent & Shaft	34-063-999-10	**	--
SW11	Sw Detent & Shaft	34-063-999-11	**	--
R134	Res Var 10K ±10% with ±5% linearity	40-419-001	Allen-Bradley	PT112M obd

* obd = order by description

SWITCH BOARD 1 04-117-511

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
SW13,14,15,16	Sw Pushbutton 6 P 12 Pos	34-074-001	**	--
R87,92,97	Res Var 2K	40-421-001	Mallory	MTC23L4

* obd = order by description

SWITCH BOARD 2 04-117-511

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
R86,91,96	Res Met Film 7.68K 3/4W 1% T-0	40-002-076	IRC	CCB obd
R98	Res Met Film 226.05Ω 3/4W 0.1% ±50ppm T-0	40-016-142	IRC	CCB obd
R93	Res Met Film 251.94Ω 3/4W 0.1% ±50ppm T-0	40-016-143	IRC	CCB obd
R88	Res Met Film 254.66Ω 3/4W 0.1% ±50ppm T-0	40-016-144	IRC	CCB obd
R85	Res Met Film 1800.1Ω 3/4W 0.1% ±50ppm T-0	40-016-158	IRC	CCB obd
R90,95	Res Met Film 1981.4Ω 3/4W 0.1% ±50ppm T-0	40-016-160	IRC	CCB obd

* obd = order by description

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REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
SW11	Sw Wafer 1 P 11 Pos Shtg	34-063-207	**	--
R85	Res Met Film 243K 3/4W 1% T-0	40-002-112	IRC	CCB obd
R135	Res Met Film 1K .25W 10%	40-012-001	Allen-Bradley	CB1021
R43,44	Res Met Film 80.6Ω 3/4W 0.1% ±50ppm T-0	40-016-024	IRC	CCB obd
R25,26,27,28, 29,30,31,32, 33,34	Res Met Film 806Ω 3/4W 0.1% ±50ppm T-0	40-016-048	IRC	CCB obd
R35,51	Res Met Film 2015Ω 3/4W 0.1% ±50ppm T-0	40-016-054	IRC	CCB obd
R37,49	Res Met Film 1289.6Ω 3/4W 0.1% ±50ppm T-0	40-016-058	IRC	CCB obd
R41,45	Res Met Film 332.3Ω 3/4W 0.1% ±50ppm T-0	40-016-145	IRC	CCB obd
R101	Res Met Film 403Ω 3/4W 0.1% ±50ppm T-0	40-016-147	IRC	CCB obd
R39,47	Res Met Film 725.5Ω 3/4W 0.1% ±50ppm T-0	40-016-153	IRC	CCB obd
C1	Cap Mica 20pf 300V 3%	45-001-003	Electro-Motive	DM15C200H0300 WV4CR
C3	Cap Mica 22pf 300V 3%	45-002-002	Electro-Motive	DM15E220H0300 WV4CR
C2	Cap Var 2-8pf	45-504-002	Erie	538-006-89R(NPO)

* obd = order by description

VOLTAGE DIVIDER BOARD 6 04-117-511

REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
SW10	Sw Wafer 1 P 11 Pos Shtg	34-063-007	**	--
SW12	Sw Wafer 1 P 11 Pos Shtg	34-063-207	**	--
R103	Res Met Film 22162Ω 3/4W 0.1% ±50ppm T-0	40-016-163	IRC	CCB obd
R99	Res WW .36Ω .25W 0.1% ±60ppm	40-147-003	Daven	1274 obd

* obd = order by description

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REFERENCE DESIGNATOR	DESCRIPTION	W-L PART NO.	MANUFACTURER	MFR. PART NO.
R30,55	Res Met Film 14.7Ω 3/4W 1% T-0	40-002-008	IRC	CCB obd
R68,69	Res Met Film 80.6Ω 3/4W 1% T-0	40-002-026	IRC	CCB obd
R67,70	Res Met Film 324Ω 3/4W 1% T-0	40-002-040	IRC	CCB obd
R66,71	Res Met Film 732Ω 3/4W 1% T-0	40-002-047	IRC	CCB obd
R53,54,55,56, 57,58,59,60, 61,62,63	Res Met Film 806Ω 3/4W 1% T-0	40-002-048	IRC	CCB obd
R65,72	Res Met Film 1.27KΩ 3/4W 1% T-0	40-002-056	IRC	CCB obd
R64,73	Res Met Film 2.05KΩ 3/4W 1% T-0	40-002-062	IRC	CCB obd
R10,12	Res Met Film 3.32KΩ 3/4W 1% T-0	40-002-067	IRC	CCB obd
R16,23	Res Met Film 146.53Ω 3/4W 0.1% ±50ppm T-0	40-016-022	IRC	CCB obd
R1-9	Res Met Film 80.6Ω 3/4W 0.1% ±50ppm T-0	40-016-024	IRC	CCB obd
R15,17	Res Met Film 82.5Ω 3/4W 0.1% ±50ppm T-0	40-016-025	IRC	CCB obd
R18,22	Res Met Film 87.93Ω 3/4W 0.1% ±50ppm T-0	40-016-026	IRC	CCB obd
R14,24	Res Met Film 219.8Ω 3/4W 0.1% ±50ppm T-0	40-016-032	IRC	CCB obd
R19,21	Res Met Film 43.96Ω 3/4W 0.25% ±50ppm T-0	40-017-001	IRC	CCB obd
R11,13	Res Var 750Ω	40-420-001	Mallory	MTC751L1

* obd = order by description

MANUFACTURERS FEDERAL SUPPLY CODE NUMBER

MANUFACTURER	ADDRESS	FEDERAL SUPPLY CODE
Allen-Bradley Co.	Milwaukee, Wisc.	19615
Amphenol Connector Div.	Broadview, Ill.	02660
Bussman Manufacturing Div.	St. Louis, Mo.	71400
Centralab, Inc.	Chicago, Ill.	71365
CTS Corporation	Elkhart, Indiana	71450
Dage Electric Co. Inc.	Franklin, Ind.	95712
Daven Div., McGraw-Edison	Milwaukee, Wisc.	36375
Elco Corp.	Willow Grove, Pa.	91662
Electro-Motive Mfg. Co. Inc.	Willimantic, Conn.	72136
Elpac Components Div.	Newport Beach, Calif.	92660
Erie Tech. Prods. Inc.	Erie, Pa.	71982
Fairchild Electro-Metrics	Amsterdam, N.Y.	18581
General Electric Co. Capacitor Dept.	Hudson Falls, N.Y.	01002
General Electric Co. Lamp Div.	Nela Park, Ohio	24455
Helipot Div., Beckman Instruments Inc.	Fullerton, Calif.	30646
IMC Magnetics Corp.	Maywood, Calif.	99743
IRC, Div TRW Inc.	Philadelphia, Pa	75042
Klixon Div., Texas Instruments Inc. Control Products Div.	Attleboro, Mass.	82647
Littlefuse Inc.	Des Plaines. Ill.	75915
Mallory Capacitor Co. Div. P.R. Mallory & Co. Inc.	Indianapolis, Ind.	37942
Marco-Oak, Div. Electro/Netic Corp.	Anaheim Calif.	87034
Memcor Div., LTV Electro Systems	Hunington, Ind.	73978
Motorola Semiconductor Products Inc.	Phoenix, Ariz.	04713
Radio Corp of America	Somerville, N.J.	02735
Sprague Electric Co.	N. Adams, Mass	56289

MANUFACTURER	ADDRESS	FEDERAL SUPPLY CODE
Stackpole Electrical/ Mechanical Products Div.	St. Mary's, Pa.	05371
Texas Instruments Inc. Semiconductor Components Div.	Dallas, Texas	01295
TRW Thompson Ramo Wooldridge Inc.	Ogallala, Neb.	84411
Tower Mfg. Corp.	Providence, R.I.	87930
Vishay Resistor Prod. Div. Vishay Intertechology	Malvern, Pa.	18612
Wakefield Engr. Inc.	Wakefield, Mass.	05820
Ward Leonard Electric Co.	Mt. Vernon, N.Y.	63743
Weston Instruments Inc.	Lexington, Mass.	11842
H.H. Smith	Brooklyn, N. Y.	Not Listed

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